THE JOURNAL

OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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ISSUES OF THE JOURNAL WANTED

The Society wishes to secure copies of the following issues of The Journal: Mid-November 1906, Mid-October 1907, May 1908, October 1909, October 1910, January 1911. These will be purchased from members at 25 cents a copy.

SPRING MEETING

The Spring Meeting will this year be held in Cleveland, Ohio, and committees are already actively at work on the preparations. An Executive Committee has been formed, consisting of Past-President Ambrose Swasey, Chairman, R. H. Fernald, Vice-Chairman, F. W. Ballard, Secretary, R. B. Sheridan, Treasurer, Worcester R. Warner, Past-President, S. T. Wellman, Past-President; E. P. Roberts, G. E. Merryweather, and A. G. McKee, with the following sub-committees: Finance: R. B. Sheridan, Chairman; J. D. Cox, A. B. McNairy, A. Ward Foote, George Bartol, E. H. Whitlock; Entertainment: R. H. Fernald, Chairman; W. R. Warner, S. T. Wellman, Chas. F. Brush, F. A. Coleman, C. E. Pope, H. H. Hill, S. R. Sague, H. F. Stratton; Publicity: E. P. Roberts, Chairman; H. M. Lane, R. I. Clegg, David Gaehr, Geo. R. Murray, F. H. Vose; Transportation: Geo. E. Merryweather, Chairman; S. A. Hand, Geo. R. Wadsworth, H. B. Anderson, C. C. Robbins; Accomodations: Arthur G. McKee, Chairman; H. M. Lucas, W. J. Reilly, Albert H. Bates, E. C. Peck. The committee is preparing interesting literature in connection with the history of the Society and the points of commercial and historical interest of Cleveland.

In this connection the Committee on Meetings announce that, in view of the plans under way for the professional sessions, the latest date at which papers can be received for the Spring Meeting will probably be April 15.

COMING MEETINGS

PHILADELPHIA MEETING, MARCH 7

On March 7 the Society will coöperate with the Franklin Institute in a meeting on the Electrification of Main Line Railways. Wm. J. Clark, manager of the traction department of the General Electric Company, New York, will address the meeting.

NEW YORK MEETING, MARCH 12

At the meeting of the Society in New York on March 12, Practical Problems in Tap and Screw Making will be presented by Frank O. Wells, president and treasurer of the Wells Brothers Company, Greenfield, Mass. The importance of size and lead in the cost of assembling manufactured work will be treated, as well as the practical limits of accuracy, reasons for abandoning the V-thread, the proper size of tap drills, the power required for tapping, the effect of lubricants on size and power, and other interesting points.

A number of prominent tap makers, including members of the Tap Makers Association, have been invited to discuss the subject and have expressed their desire to attend, and it is expected that the meeting will bring out much interesting data.

BOSTON MEETING, MARCH 15

A paper upon Results of Tests on the Discharge Capacity of Safety Valves, by Prof. E. F. Miller, professor of steam engineering at the Massachusetts Institute of Technology, and A. B. Carhart, superintendent of the Crosby Steam Gage & Valve Company of Boston, will be presented at a meeting of the Society in Boston on March 15.

NEW HAVEN MEETING, APRIL 17

A meeting of the Society will be held in New Haven on the afternoon and evening of Wednesday, April 17, in the Mason Laboratory of Mechanical Engineering. The topic for consideration will be The Cost of Production.

REPORTS OF MEETINGS

ST. LOUIS MEETING, FEBRUARY 7

A meeting of the Society was held in St. Louis on February 7, in which other engineering societies having representatives in that city were invited to coöperate. A paper on A Comparison of Air Braking Systems for Urban Electric Railway Cars, by Charles W. Young and Charles A. Hobein, both of the United Railways Company, St. Louis, was read by the latter, which described the two systems commonly used for single cars in modern city service, and gave data on investment, operation, maintenance and depreciation costs.

The paper was discussed by Richard McCulloch, vice-president and general manager of the United Railways Company, John Hunter, Mem. Am. Soc. M. E., chief engineer of the Union Electric Light & Power Company, F. A. Berger, Mem. Am. Soc. M. E., assistant professor of mechanical engineering at Washington University, A. L. Langsdorf, professor of electrical engineering and dean of the school of engineering, Washington University, G. W. Lamke, instructor in electrical engineering, Washington University, M. L. Holman, Past-President Am. Soc. M. E., consulting engineer, Professor Van Maur, and Mr. Metzger.

NEW YORK MEETING, FEBRUARY 13

The American Institute of Mining Engineers coöperated in a meeting of the Society held in the Engineering Societies Building on Tuesday evening, February 13, when a paper on the Design and Mechanical Features of the California Gold Dredge, by Robert E. Cranston, was presented by E. Gybbon Spilsbury, a member of both the organizations.

The paper gives detailed information in regard to all conditions necessary for the design of a gold dredge, and describes the present California type, which is a combination of the New Zealand type and several others. The buckets are made with a cast steel base, pressed steel hood and manganese steel lip. The lower tumbler is a six-sided steel casting with renewable wearing plates over which the buckets pass. They then travel up a structural steel ladder on

rollers and over a six-sided upper tumbler which is driven by a chain of cast-steel gears. The buckets dump their material into a hopper which discharges into a shaking or revolving screen. The fine material goes through onto gold-saving tables and the coarse material is stacked aft of the dredge by means of a belt conveyor. The dredge is held in place by steel spuds and moved by means of side lines running to a motor-driven winch. The digging ladder is raised by means of a separate winch driven by the digging motor. Water is furnished under pressure by motor-driven centrifugal pumps. The hull is built of Douglas fir and should be designed last.

The paper was illustrated by lantern slides, as was also a discussion by Charles Whiting Baker, editor of Engineering News, who showed the types of dredge used in the work on the Panama Canal. H. D. Hibbard of Plainfield, N. J., George A. Orrok of New York, R. M. Stanton, Jesse M. Smith, Past-President of the Society, John M. Sherrerd of the Taylor Iron & Steel Company, High Bridge, N. J., and A. F. Lowy also discussed the paper.

PHILADELPHIA MEETING, FEBRUARY 14

A meeting of the Society was held in Philadelphia on February 14, in which the Engineers Club, the Franklin Institute and the Society of Automobile Engineers coöperated. Charles Y. Knight, inventor of the Knight silent motor, was the speaker of the evening.

The problem he set out to solve, he said, was the development of a quiet or silent internal-combustion engine for automobiles, previous developments of the slide-valve type of internal-combustion engine having been abandoned on account of the inability to obtain proper lubrication. In Europe the roads are much straighter and have a better surface than our roads and maximum speed can be maintained for a longer period of time, and the block test, therefore, of the automobile motor in the best shops is very much more severe than it is here. He described the test of his motor before the Royal Society and stated that the sleeve-valve motor of his design ran through the continuous test of five nights and six days, developing an actual horsepower of 54.2 by his 38 h.p. English rated motor and 34 and a fraction h.p. with his 22 h.p. English rated motor and that after this block test the motors were placed in cars and run on the track 4000 miles and taken down and calipered, and showed no appreciable wear. He showed from sections thrown on the screen the valve action and the effect of the split ring in the top of the

cylinder, and laid special stress on the absolute necessity of close-fitting pistons and gave the figure of 0.003 in. as a proper clearance. He also said that this same clearance was allowed between the sleeves and that with this clearance a film of oil was easily maintained and gave ample lubrication.

One of the advantages of the sleeve valve motor which he claimed was the avoidance of irregular sections in the cylinder design which under load conditions warped from their original shape and caused the pistons to seize or require additional clearance between pistons and cylinder. The sleeves of his engine, he said, would give slightly from their original shape and instead of having simply 0.003 in. of clearance for allowable warpage of cylinder wall, he practically had 0.009 in. The tops of his cylinders were machined all over, as well as the tops of the pistons, giving uniform clearance in each cylinder and presenting a machine surface which is not apt to hold carbon as a plain cast surface.

At the close of the meeting a unanimous vote of thanks was given to Mr. Knight for his address.

BOSTON MEETING, FEBRUARY 16

A meeting of the Society was held in Boston on Friday evening, February 16, when the subject of Aviation was presented in a paper by Albert A. Merrill, embodying the results of his extended study and experiments in this field. Mr. Merrill went very fully into the principles governing the construction of aeroplanes, especially with reference to stability and control, and advocated developing control along the lines indicated by the instinctive movements of the operator. With the aid of numerous slides he traced the progressive development of various types of control and described the improvements in this particular developed by himself.

His presentation was followed by an informal discussion.

EDISON MEDAL FOR GEORGE WESTINGHOUSE

At the meeting of the board of directors of the American Institute of Electrical Engineers, held January 12, the Edison Medal Committee reported that the Edison gold medal for the year 1911 had been awarded to George Westinghouse, Hon. Mem. Am. Soc. M. E., "for meritorious achievement in connection with the development of the alternating-current system for light and power." The medal will be presented to Mr. Westinghouse at a meeting to be arranged.

STUDENT BRANCHES

ARMOUR INSTITUTE OF TECHNOLOGY

The Armour Institute of Technology Student Branch was addressed by Calvin W. Rice, Secretary of the Society, on January 31, his subject being the work of the Society and the advantages it offers to student branches.

On February 7, K. M. Boblett, Mem. Am. Soc. M. E., spoke on Automobile Radiators, and his lecture was illustrated by samples and models of various types of radiators. The radiating effect of each type, as well as the details of construction with reference to efficiency and economy of manufacture, were fully dealt with. A discussion followed.

CORNELL UNIVERSITY

Sibley College Student Branch held a meeting January 15, when Howard D. Hess, Mem. Am. Soc. M. E., read a paper on Some Recent Developments in Iron and Steel Manufacturing. The talk was illustrated with a number of lantern slides.

On January 24 the mechanical and electrical societies coöperated in a meeting at which Professor Sampson read selections and Professor Brown talked on Chemistry and Its Relation to the Engineer, with special reference to radio-activity.

LELAND STANFORD, JR., UNIVERSITY

The Stanford Mechanical Engineering Association recently elected the following officers for the coming semester: C. W. Scholefield, chairman; C. P. Campbell, vice-chairman; V. W. Winter, secretary-treasurer.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

On December 12 the Mechanical Engineering Society of the Massachusetts Institute of Technology held a meeting at which A. R. Davis and D. Dasso, Students, 1911, presented a paper on High-Speed Gasolene Engines. Mr. Davis discussed the general theory of the different types of engines, features of different carbureters and ignition systems; while Mr. Dasso considered a dozen different engines, most of which were of foreign design, discussing the good and objectionable features of each.

OHIO STATE UNIVERSITY

At a meeting of the Ohio State University Student Branch on January 15, the paper by S. H. Bunnell on Expense Burden was discussed.

On January 22, the following officers were elected for the coming semester: J. P. Stewart, chairman; J. Tom, vice-chairman; H. F. Belt, secretary; G. Burrell, treasurer.

POLYTECHNIC INSTITUTE OF BROOKLYN

On February 3 the Student Branch of the Polytechnic Institute of Brooklyn held a meeting at which Mr. Maujer of Power presented a paper on Power Plants in the West. W. D. Ennis, A. A. Adler and G. A. Orrok discussed the paper.

On February 10 the De La Vergne Company's plant was inspected by the students.

STATE UNIVERSITY OF KENTUCKY

The Student Section of the State University of Kentucky held a meeting January 9, at which Calvin W. Rice, Secretary of the Society, gave an address on the work of the Society and the benefits of the membership in it.

STEVENS INSTITUTE OF TECHNOLOGY

Charles N. Chadwick of the Board of Water Supply of New York City, lectured before the Stevens Engineering Society, February 8, on the Water Supply of a Great City. The Catskill Aqueduct was described in a very instructive manner and the lecture was illustrated by lantern slides.

On February 18 Thomas Travis gave a talk on The Criminal from a Scientific Standpoint. Calvin W. Rice, Secretary of the Society, introduced the speaker.

UNIVERSITY OF CINCINNATI

The University of Cincinnati Student Section held its regular monthly meeting, February 9. Walter W. Franz, Mem. Am. Soc. M. E., gave an interesting talk on the university's new power plant, designed by him. The plant was afterwards inspected by the members present, the student branch of the American Institute of Electrical Engineers being the guests of the evening.

UNIVERSITY OF ILLINOIS

The University of Illinois held a meeting January 12, at which E. P. Bradley read a paper on The History and Development of the Vacuum Heating System. A general discussion followed.

UNIVERSITY OF KANSAS

On January 8, Calvin W. Rice, Secretary of the Society, spoke before the Student Branch of the University of Kansas on the advantages offered by membership in a body. One of the papers of the evening was Tests of Large Boilers at the Detroit Edison Company, by D. S. Jacobus, presented by C. G. Martinson, Student, 1910. A discussion by Perley F. Walker, Mem. Am. Soc. M. E., followed. The Plant of the Bucyrus Company in South Milwaukee, by E. Carson, and The Manufacture of Waterman Fountain Pens, by P. L. Reymond, Student, 1911, were also presented.

On January 26 the following papers were presented: J. M. Jenks' Valve Gear for Gas Engines, Mr. Kleigh; Producer Gas from Crude Oil, V. H. Hilford, Student, 1911; Automobile Engines, Mr. Angevine; Stubbers Gas Machine, A. H. Sluss. The last consisted of a talk on the design and construction of a constant pressure gas machine, invented by a man with no technical skill.

UNIVERSITY OF MISSOURI

Tests of Large Boilers at the Detroit Edison Company, by D. S. Jacobus, was read and discussed at a meeting of the Student Branch of the University of Missouri on January 22.

Officers elected for the coming semester were: A. C. Edwards, chairman; F. I. Kemp, secretary-treasurer; P. A. Tanner, corresponding secretary.

YALE UNIVERSITY

The Mechanical Engineers' Club of Yale University held a meeting on February 6, when a paper was read by B. W. Hill, Student, 1911, on Farming by Mechanical Power. It was illustrated by lantern slides and demonstrated the superiority of mechanical power over horse power in farming.

MEETING OF THE COUNCIL

A meeting of the Council was held on February 13 in the rooms of the Society. There were present, Alex. C. Humphreys, President, presiding; Ira N. Hollis, E. B. Katte, F. R. Hutton, E. D. Meier, George A. Orrok, Jesse M. Smith, T. B. Stearns, H. H. Vaughan, R. M. Dixon, Calvin W. Rice, Secretary, and, by invitation, George J. Foran, Chairman of the Committee on Membership, and I. E. Moultrop, Chairman of the Committee on Increase of Membership. Regrets were received from H. G. Reist, D. W. Crawford, and Stanley G. Flagg.

The minutes of the meeting of January 9 were read and approved.

The President announced the following additional committee appointments: Finance Committee, W. D. Sargent; New York Committee on Meetings, H. R. Cobleigh; Tellers of Election, George L. Hoxie and Theo. Stebbins.

The deaths of E. K. Sancton and W. F. Buck were reported.

The conduct of the Annual and Semi-Annual Meetings were discussed and it was the sense of the Council that the Annual President's Reception be made a function of the Society and the expense of same charged to the appropriation of the House Committee.

Voted: That the budget appropriation for the House Committee be increased by $551.53 in the current fiscal year, to cover the expenses of the President's Reception in December 1911.

The Council devoted considerable attention to ways and means of extending the Society's usefulness to a larger circle of the profession and the policies recommended by I. E. Moultrop, former member of the Council and chairman of the Committee on Increase of Membership, were in general favored. The Committee on Increase of Membership and the Membership Committee, George J. Foran, Chairman, were invited to prepare a statement and submit to the Council at the earliest possible date.

The Research Committee submitted to the Council the recommendation that the Council authorize the procedure of an investigation of the laws governing the transmission of heat through metallic tubes:

Resolved: That the Council considers further investigation of the laws governing the transmission of heat through metallic tubes highly interesting and important, and heartily endorses a consideration of that subject by the Research Committee; while the Council wishes to commend the promotion of all such work on the part of the Research Committee, it is to be regretted that the Society has not the available money for such purpose.

Voted: To approve the recommendation of the Publication Committee that the price of The Journal be made $3 to every one not a member or an affiliate of The American Society of Mechanical Engineers, and that the Secretary be directed to amend any previous action of the Council directing otherwise.

Voted: That the request of the St. Louis Committee on Meetings, to organize under the provisions of C 52 for formation of geographical sections be referred to the Executive Committee for report back to the Council.

Voted: That the communication from the Institution of Civil Engineers of Great Britain, asking that the American Society join in the erection of a memorial window to Lord Kelvin in Westminster Abbey, be referred to the President with power.

Voted: To approve the formation of a Student Branch at the University of California, Berkeley, Cal.

On motion the meeting adjourned.

SOME TESTS ON CARBURETERS

By George W. Munro

ABSTRACT OF PAPER

The paper outlines the problem of carburation for motor vehicle engines and points out the difficulties met in determining the performance of a carbureter as distinct from the performance of the engine to which it is attached.

Results of 400 economy tests on a single engine served by six different carbureters under identical conditions of speed and load are presented in graphical form. By these it is shown that the performance characteristics are different with the different carbureters and that the carbureter characteristics would be determined if those of the engine on which they are superposed were known. Approximate engine characteristics are developed for comparison by using the best performance obtained with any carbureter.

Attention is called to the economic importance of the carbureter, the desirability of applying more scientific methods in its development, and the necessity of having available a testing plant, the constants of which are well determined.

SOME TESTS ON CARBURETERS

By George W. Munro, Lafayette, Ind.

Affiliate of the Society

The carbureter used on vehicle motors is a machine for mixing liquid gasolene with air in such proportions that the motor will always be supplied with combustible mixture suitable for explosive burning behind the engine piston. For satisfactory service it must respond automatically to the engine demand, whether light or heavy; and must be so well designed and built as to function under the most trying conditions of vibration and jar, and in any position less than complete overturn. Its action must not be seriously affected by weather conditions and provision must be made for meeting readily wide variation in character of fuel supply.

2 Increase in demand may result either from additional load or increase in piston speed. The heavy load at low-speed results in an intermittent carbureter action, while at the higher speeds the flow of mixture to a multiple-cylinder motor is nearly continuous. So in addition to responding to a quantity change, the carbureter must also meet a variation in the character of the demand.

3 Until recently, effort was centered in meeting these operative conditions, and but little consideration was given to cost of operation. With the growing popularity of the automobile and motor boat, however, and the advent of a number of carbureters giving satisfactory service, questions of fuel economy arose, demanding comparative tests and performance. Here the lack of established methods of testing, the absence of standards of comparison and even a too limited nomenclature, prove troublesome.

THE PROBLEM OF CARBURETER TESTING

4 The peculiar features of the problem are that a carbureter is used only in connection with an engine and so should properly be tested in use upon it, thus introducing engine characteristics into all results. Again, the engine requires a carbureter for operation, and so its performance can not be determined free from carbureter factors. From this it appears that the two must be tested together,

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and the securing of a proper standard for comparison of results is most important.

5 As the best possible performance of the engine marks also the best possible carbureter action, the complete determination of the engine characteristics would establish a basis for comparing the behavior of any carbureter which might be used. Owing, however, to the fact that the characteristics of some carbureters are always superimposed on those of the engine, the limitations due to such purely engine factors as compression, shape of the clearance space and friction, can not be readily determined. However, if an engine were tested under the same running conditions with a large number of carbureters, some one of them might furnish a perfect mixture and the best possible performance of the engine would be realized. The repetition of this process with a large number of running conditions would ultimately result in defining completely the engine performance.

6 It is too much to expect that this result could be accomplished by testing only six carbureters, but lacking any other standard the best result obtained under each running condition has been plotted on each sheet of results for comparison.

SCOPE OF THE WORK

7 The six carbureters were tested under identical engine conditions through a range of ten speeds from 300 to 1200 r.p.m. At each speed, tests were run with 10, 20, 30, etc., lb. net load on the brake up to the maximum which could be carried, making 80 tests with each carbureter.

8 The impossibility of maintaining all the conditions and lack of time made it impossible to complete all of the series, but a total of 401 tests was secured, with results so consistent as to indicate the essential accuracy of the work. In addition, the experimental work involved the repetition of one entire carbureter series, due to a broken crankshaft and consequent change of engines after the work with the first carbureter had been completed. A seventh carbureter was also tested, the results of which are omitted for reasons discussed elsewhere.

THE CARBURETERS

9 The carbureters, selected to represent as widely different types as possible, covered the standard construction of the different manufacturers at the time they were loaned or donated for the purpose of the investigation. The details of carbureter con-

struction have changed so rapidly, however, in the two years since, that the results should now be interpreted as applying to the type of instrument, rather than to the particular output of any manufacturer.

10 Carbureter *A* (Fig. 1) is a concentric float-feed, single-jet, auxiliary air-valve carbureter in which the auxiliary air supply is regulated by an adjustable spring controlling a light flat-seat metal valve.

11 Carbureter *B* (Fig. 2) is a concentric float-feed, single-jet type with floating ball auxiliary air valves, in which the auxiliary air

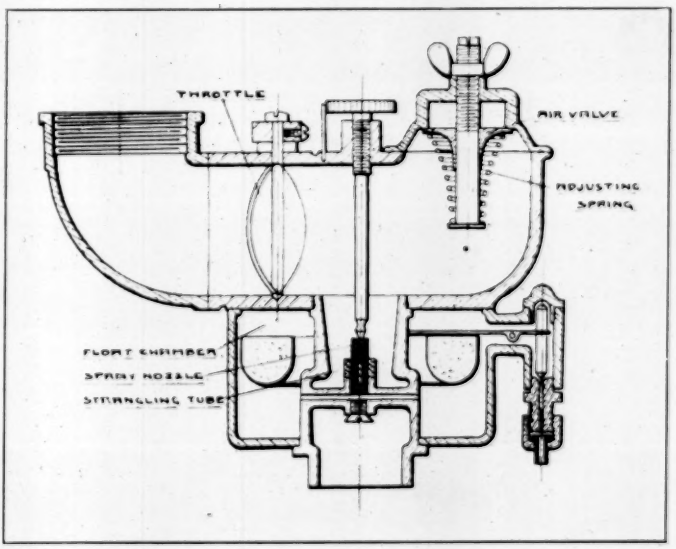

FIG. 1 CARBURETER *A*

enters by raising the ball valves in their cages in response to the suction caused by increase of engine demand. Both these carbureters have many points of resemblance and were chosen because of the difference in auxiliary air control.

12 Carbureter *C* (Fig. 3) is of the concentric float feed type, but has no needle valve, the adjustment for fuel characteristics being made by changing gasolene nozzles. The auxiliary air valve is controlled by two springs, one of which comes into action only under conditions of high demand. Carbureters *A*, *B* and *C* have in common the same general design features; a gasolene nozzle with constant level fuel supply around which passes an unregulated air current,

the air velocity being increased at the nozzle tip by a constriction of the air passage at that point. As this device gives a mixture too rich to be explosive at all except under the conditions of lightest demand, provision is made for the admission under automatic control of additional air to dilute the mixture to required proportions. The notable differences consist of various automatic air controls, fuel controls to the nozzles and forms of the constant air supply passages. Of these the automatic air control was considered the

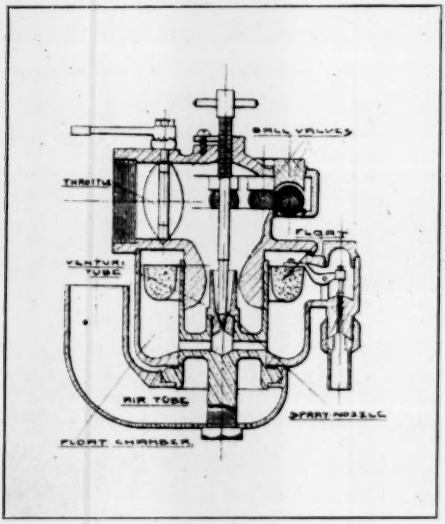

FIG. 2 CARBURETER *B*

most important and was the controlling factor in the selection of these carbureters for this work.

13 Carbureter *D* (Fig. 4) is a float-feed, two-jet, automatic-valve type, the automatic valve operating to keep one jet from service except under conditions of high demand. When the demand increases beyond the capacity of the first nozzle, the increased suction opens the valve above the second jet, which is of the cone multiple spray type, additional mixture being thus secured.

14 Carbureter *E* (Fig. 5) is a float-feed, multiple-jet type with floating venturi air tubes surrounding the nozzles. The jets, four in number, are successively brought into action as the piston throttle is operated to uncover their ports, the floating of the air tube being intended to maintain constant quality of mixture throughout the range of each jet.

15 Carbureter *F* (Fig. 6) is of the concentric float feed, puddling type, a gasolene puddle being formed in the bottom of the U-shaped air passage under conditions of light demand. With increased demand the puddle disappears by evaporation, the fuel supply being restricted by the needle valve. No auxiliary air supply is provided in this carbureter, the puddle furnishing mixture sufficiently rich for starting with air supply wide open.

16 Carbureter *G* is one of the very early machines equipped with a lifting needle under control of the throttle. Its behavior on test leads to the belief that it is not representative of the type and so no interest attaches to the results, which are not given. It is mentioned

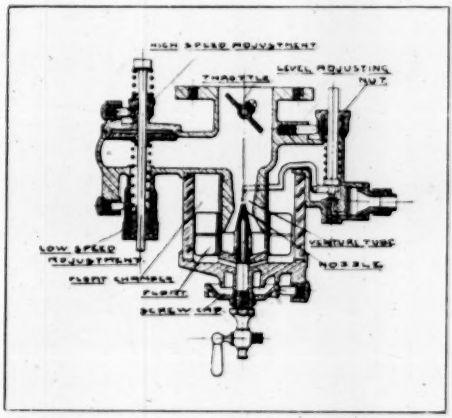

FIG. 3 CARBURETER *C*

here only because it gave maximum economy under a number of conditions, which results have been plotted for comparative purposes.

TESTING PLANT

17 The tests were made on a new Rutenber 4-cylinder, 4-cycle automobile engine. The cylinders, $4\frac{1}{2}$ in. in diameter by 5 in. stroke, were each equipped with a single spark plug and the timer controlling the ignition system was provided with a pointer and scale, showing the ignition point with reference to the inner dead center in degrees of crankshaft position.

18 The power was measured and absorbed by a prony brake having an arm of a 2.1875 ft. radius, bearing on platform scales. An oil drip on the brake-wheel rendered the brake very sensitive and eliminated all tendency of the engine to "hunt."

19 Speed was determined by an indicating tachometer carefully calibrated for the speeds to be maintained.

20 The fuel, ordinary stove gasolene, had a specific gravity of 0.723 and was supplied from a vertical cylindrical tank having a gage glass and scale properly calibrated.

21 The cooling water for the motor was stored in a large tank out of doors and after use was discharged to the sewer.

22 The operation of the plant was in every way satisfactory and

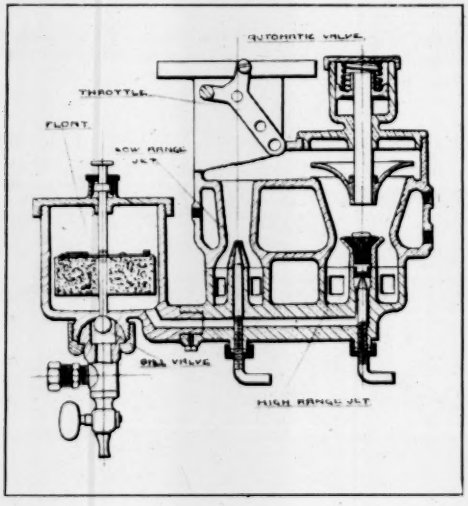

FIG. 4 CARBURETER *D*

conditions of speed and load, once established, could be maintained constant as long as desired.

ADJUSTMENT

23 In preparing for the tests the engine was "tuned up" by adjusting the carbureter for range and economy as follows: To maintain the maximum load at 1200 r.p.m.; to give least possible fuel consumption under maximum conditions; to run light at 300 r.p.m. or slower; to accelerate properly when the throttle was opened quickly; and to attain all intermediate conditions under throttle and spark control without misfires, backfires or noticeable smoke at the exhaust. This "tuning up" with each carbureter in turn was done by a man of experience and skill, and it is believed that the adjustments were uniformly good.

THE TESTS

24 After adjustment the speed was brought to 300 r.p.m., the brake load adjusted to 10 lb., the cooling water regulated to give desired conditions and a 6-minute test made, readings of fuel consumption and temperature of outgoing cooling water being taken at 1-minute intervals. The temperatures of the room and incoming cooling water remained nearly constant and were taken only at the beginning and end of each test.

25 The tests were made in the order of increasing loads and

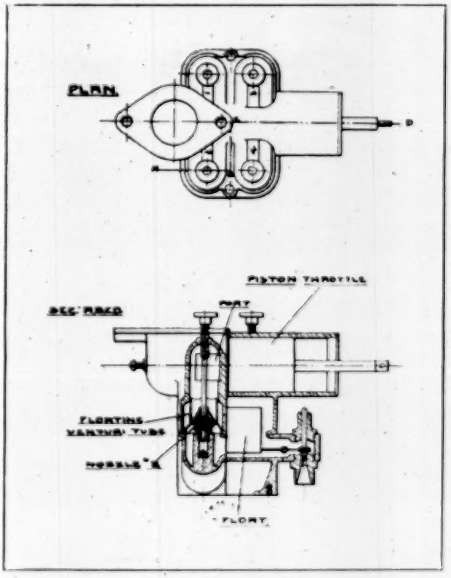

FIG. 5 CARBURETER *E*

speeds, that is, the load was increased at constant speed to the engine capacity when the speed was increased by 100 r.p.m. and the load series repeated. At all times the engine was given the most advantageous spark setting, ignition adjustment being made before each test. No adjustment of cooling water supply was made during a load series unless there seemed danger that the boiling point would be reached before the series was concluded. This shows in a gradually increasing temperature of outgoing cooling water through each load series.

26 After the ten load series were completed, a "range test" was

made, the carbureter adjustment remaining the same as throughout the economy tests. Maintaining the maximum load which the engine would carry at 1200 r.p.m., the speed was gradually decreased by throttle and spark to the lowest point at which the load could be carried. The results are given graphically in Fig. 14.

THE RESULTS

27 The results of all tests are given in graphical form in Figs. 7 to 12 inclusive. The graphical method followed in presenting results has the advantage of being concise and of furnishing certain comparisons in the process of presentation; whereas tabulation of the same data requires a quite bewildering mass of figures from

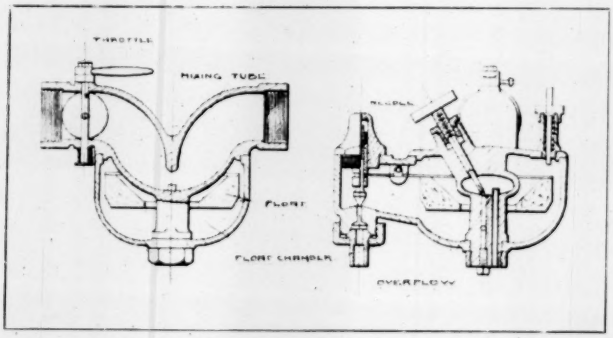

FIG. 6 CARBURETER *F*

which comparisons are drawn only with difficulty. In the matter of accuracy there is some advantage in tabulation, yet here the gain is not so great as might appear. Take, for example, the fuel consumption per hour which has been plotted to tenths of a pound, while the fuel reading was originally made to hundredths of a pound for a one-tenth hour test, making the plotting of the same accuracy as the original observation.

28 An inspection of the result sheets shows that for each load series, there might be drawn a smooth curve which would show the performance characteristic of the carbureter for that speed. These curves were not drawn in as it did not seem wise to confuse the presentation of data with its interpretation, but to illustrate the characteristics of the various carbureters Fig. 13 has been drawn giving the results obtained from all carbureters at 1100 r.p.m. Comparison of these curves with the results obtained from the same carbureters at nearby speeds shows that they are typical forms.

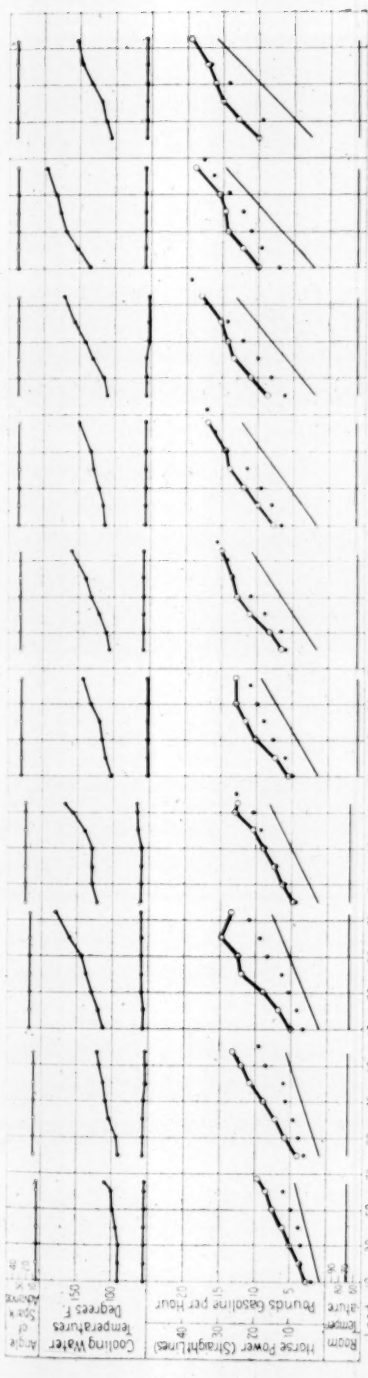

FIG. 7 RESULTS OF TESTS WITH CARBURETER *A*. BEST PERFORMANCE OBTAINED FROM ANY TEST INDICATED BY SOLID DOT

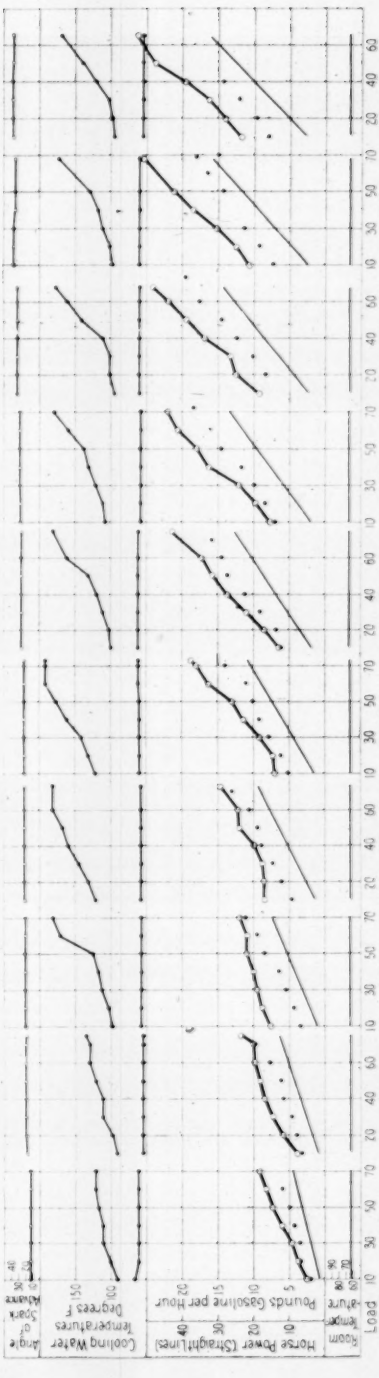

FIG. 8 RESULTS OF TESTS WITH CARBURETER *B*. BEST PERFORMANCE OBTAINED FROM ANY TEST INDICATED BY SOLID DOT

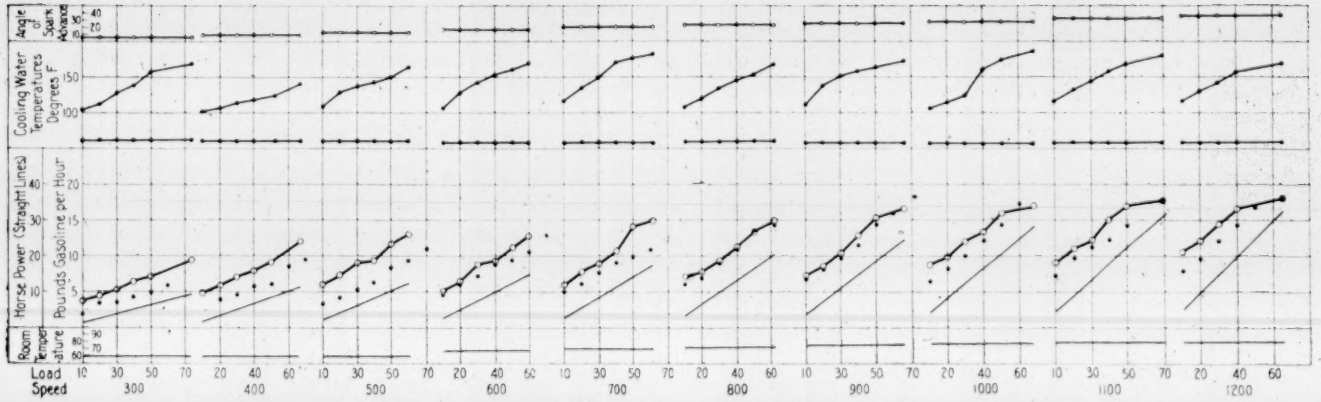

FIG. 9 RESULTS OF TESTS WITH CARBURETER *C*. BEST PERFORMANCE OBTAINED FROM ANY TEST INDICATED BY SOLID DOT

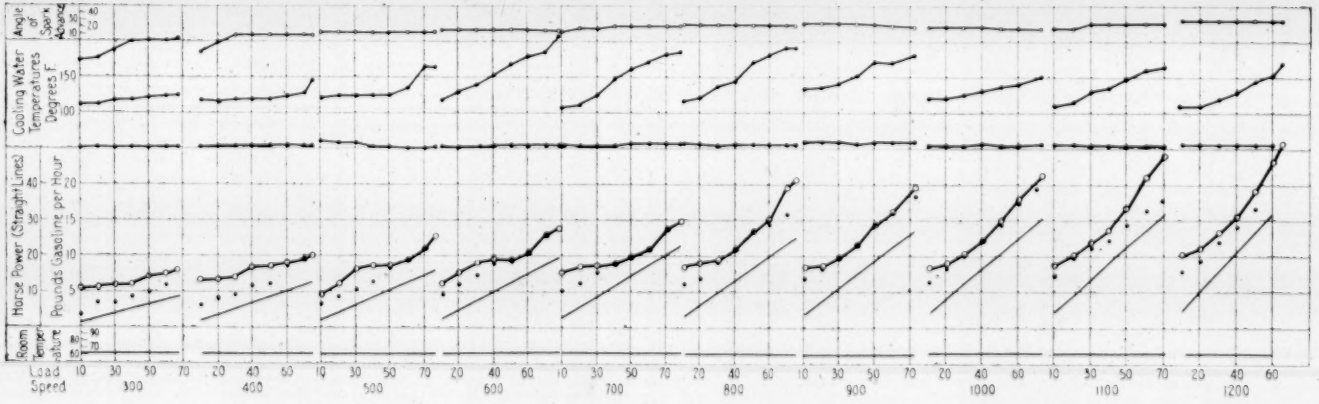

FIG. 10 RESULTS OF TESTS WITH CARBURETER *D*. BEST PERFORMANCE OBTAINED FROM ANY TEST INDICATED BY SOLID DOT

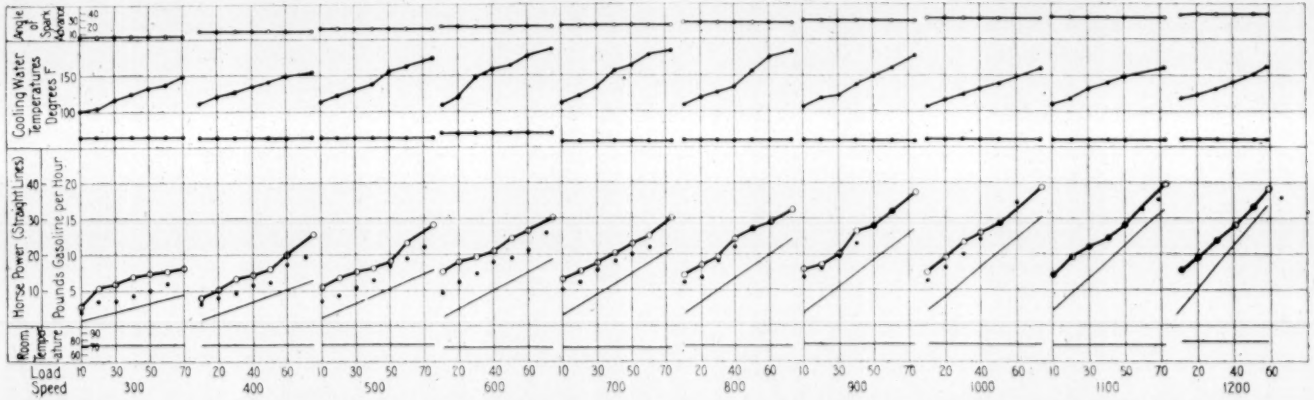

FIG. 11 RESULTS OF TESTS WITH CARBURETER *E* BEST PERFORMANCE OBTAINED FROM ANY TEST INDICATED BY SOLID DOT

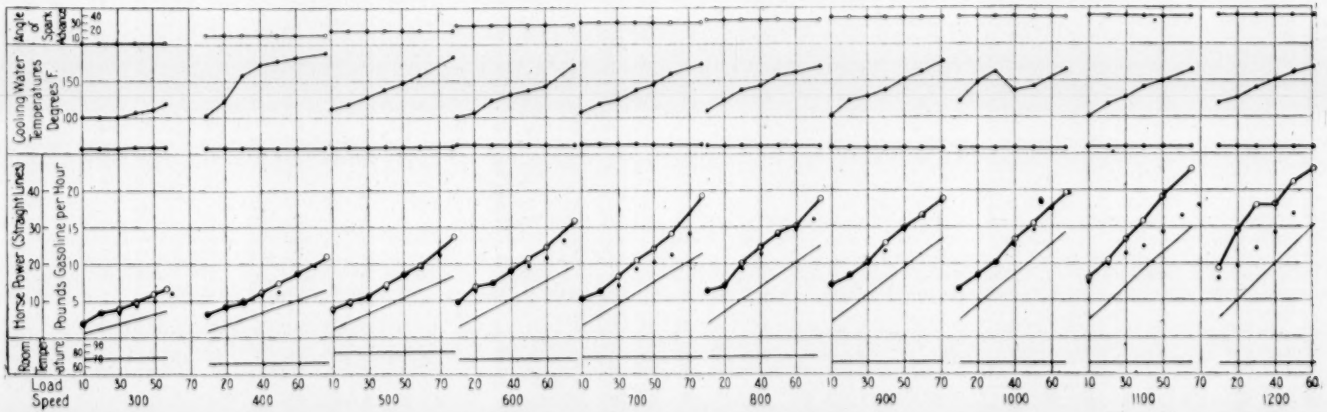

FIG. 12 RESULTS OF TESTS WITH CARBURETER *F* BEST PERFORMANCE OBTAINED FROM ANY TEST INDICATED BY SOLID DOT

ENGINE PERFORMANCE

29 As previously indicated, the best performance of the engine has a special interest in a series of carbureter tests as it forms the only available basis for comparison of carbureter action. For this reason as well as because of the interest that naturally attaches to records of engine performance, the best engine results at each speed have been shown graphically in Fig. 14, both in terms of gasolene per brake horsepower-hour, and in per cent thermal efficiency, based on an assumed calorific value of 20,700 b.t.u. per lb. of gasolene.

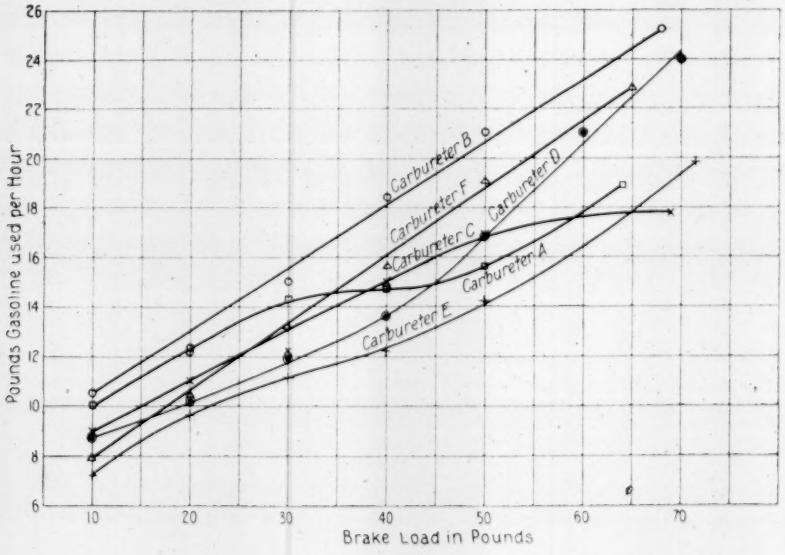

FIG. 13 CURVES SHOWING CARBURETER CHARACTERISTICS AT 1100 R.P.M.

Also the best results obtained with each load at 800 r.p.m. have been shown in Fig. 15 in the same way. Smooth curves have been drawn to assist the eye in following the points and to indicate the general trend of results. The best performance with any one carbureter has been indicated by black dots in each case for comparison.

30 Table 1 shows the maximum horsepower developed at each speed with each carbureter, together with the corresponding fuel consumption and engine efficiency.

31 The best performance, 22.2 per cent, corresponds to a fuel consumption of 0.736 pints of gasolene per horsepower hour. The highest brake load, 78 lb., demands a mean effective pressure of 81 b. to the square inch for the brake load alone. Assuming a mech-

TABLE 1 MAXIMUM POWER AND ENGINE PERFORMANCE AT EACH SPEED WITH EACH CARBURETER

R.P.M.	300			400			500			600			700			800			900			1000			1100			1200		
Carbureter	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent	Horsepower	Lb. Gasolene per hr.	Efficiency per cent
A	8.138	9.6	10.4	11.122	13.2	10.3	15.429	13.4	14.1	16.276	12.7	15.8	18.688	13.0	17.7	21.678	15.0	17.8	24.602	17.0	17.8	26.688	18.0	18.2	29.357	18.9	19.0	31.80	19.5	20.1
B	8.764	9.0	12.0	12.450	11.7	13.1	14.595	11.8	15.2	18.380	14.5	15.5	21.316	18.6	14.1	25.010	21.3	14.4	26.292	21.9	14.7	28.356	24.0	14.5	31.192	25.2	15.2	32.552	26.1	15.3
C	9.265	9.4	12.1	11.122	12.0	10.4	12.510	13.0	11.8	14.898	12.8	14.3	17.958	15.0	14.7	20.677	15.0	16.9	24.789	16.6	18.3	28.356	17.0	20.5	31.651	17.7	22.0	32.552	18.0	22.2
D	8.380	8.0	12.9	12.450	9.9	15.5	15.870	11.7	16.7	19.530	13.8	17.4	22.776	14.8	18.8	25.010	20.6	15.0	27.012	19.5	17.0	30.441	21.2	17.5	32.109	24.0	16.4	32.552	25.8	15.5
E	8.764	8.0	13.4	12.450	12.6	12.1	15.640	14.0	13.8	18.530	15.0	15.2	21.316	15.0	17.5	24.345	16.1	18.6	27.600	18.6	18.2	30.441	19.4	19.3	32.797	19.8	20.3	34.050	19.2	21.8
F	7.136	6.5	13.5	12.782	10.8	14.5	16.263	13.5	14.8	19.030	15.6	15.0	22.484	18.0	15.4	24.679	18.6	16.3	26.667	18.6	17.6	28.356	19.5	17.9	29.815	22.8	16.0	30.548	22.9	16.4

Efficiency based on assumed fuel value of 20,700 b.t.u. per lb.

anical efficiency of 85 per cent for the engine, the mean pressure on the piston would be 95 lb., which corresponds closely with the best that is obtained with the same fuel in stationary practice, and shows that conditions in the cylinder are not materially changed up to seven or eight cycles per second. Indeed, the steady increase of efficiency with speed, indicates that speed does not interfere with cylinder performance within the limits of the experiments.

CONCLUSIONS

32 A consideration of the results obtained leads to the following conclusions:

a Under identical conditions of speed and load an engine

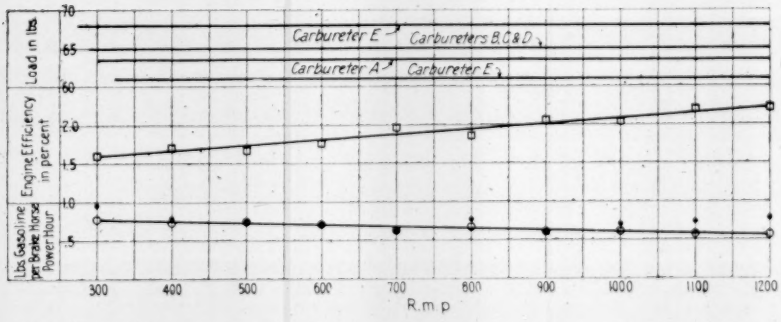

FIG. 14 CURVES SHOWING RESULTS OF RANGE TESTS AND BEST PERFORMANCE OF ENGINE AT EACH SPEED. BEST PERFORMANCE WITH SINGLE CARBURETER (CARBURETER *D*) INDICATED BY SOLID DOTS

gives materially different fuel economy when served by different carbureters.

b Carbureter action is the limiting factor in engine capacity as well as in economy.

c Wide range and perfect operation give no indication of fuel economy.

d Each carbureter has distinctive performance characteristics which may be determined and plotted.

e The characteristic may be such that a carbureter giving excellent results under some conditions may give very poor economy over a large part of its range.

33 Being the limiting element of engine capacity and economy, the carbureter is a machine of great engineering and economic importance and as such demands more scientific methods in its development than have yet been applied. This would necessitate

systematic testing and comparison, not only of widely different types, but of the same carbureter after minor changes in design.

34 A method of testing carbureters which would be independent of engine characteristics is much to be desired, as then results obtained by different experimenters in different places could be directly compared. Lacking such a method, it seems desirable that an engine be properly equipped and placed in some laboratory for the testing of carbureters, thus establishing, after the engine characteristics became thoroughly known, a definite standard available for reference. Such a standard would be valuable only in case carbu-

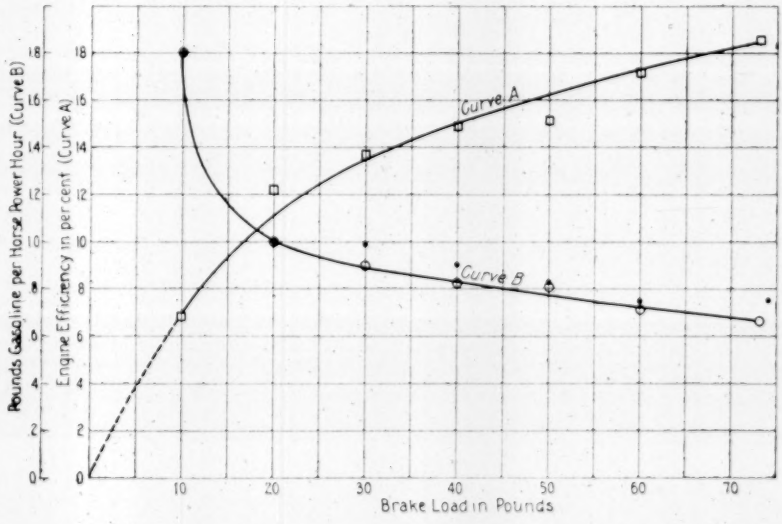

FIG. 15 CURVES SHOWING BEST PERFORMANCE OF ENGINE AT EACH LOAD SPEED CONSTANT AT 800 R.P.M. BEST PERFORMANCE WITH SINGLE CARBURETER (CARBURETER *F*) INDICATED BY SOLID DOT

reters retain their relative characteristics when transferred to different engines, which seems probable but has not yet been established experimentally.

35 This would require a large expenditure, both for plant and for operation and, undertaken as a commercial venture, would probably be attended with financial loss. Engine builders, however, spend vast sums each year in developing and perfecting their output, and when the dependence of the engine on the carbureter is considered, it would seem that several engine manufacturers might profitably unite in the systematic improvement of the carbureter.

Several states have established engineering experiment stations where problems of importance in the development of industries or the conservation of important natural resources may be thoroughly investigated, and the carbureter, important in both aspects, may properly receive their attention.

The experimental work on which this paper is based was performed in the spring of 1910 by Messrs. R. W. Noland, G. P. Rettig and J. A. Saurs, seniors in the School of Mechanical Engineering of Purdue University, in preparation of their graduating thesis. Mr. Noland had been for three years assistant in mechanical drawing at Purdue and Mr. Rettig had had a wide experience in the employ of automobile makers. Any value which the results possess is due primarily to his skill in "tuning up" an engine. It was done under the direct supervision of Mr. C. C. Austin, at that time an assistant in the gas engine laboratory, the author being in general charge of the work.

The engine upon which the tests were made was loaned for the purpose by the builders, the Western Motor Co. In addition to the experimental results the drawings of the carbureters tested are taken from the thesis.

SOME REFRACTORY SUBSTITUTES FOR WOOD

At the meeting of the Society held in Boston, November 16, 1911, the Boston Society of Civil Engineers and the Boston section of the American Institute of Electrical Engineers coöperating, a paper was presented by Prof. Charles L. Norton, Mem. Am. Soc. M. E., of the Massachusetts Institute of Technology, on Some Refractory Substitutes for Wood.[1]

The common use of wood in and around our buildings is responsible for a considerable part of the annual fire loss, and the discovery or invention of a satisfactory substitute which would possess the desirable properties of wood and yet be non-combustible has been long hoped for. It is clear that in order to be accepted as a substitute for wood in building construction, a new material must approximate in lightness, strength, elasticity and ease of working, the natural woods, and further, since the variation in natural woods fits them for special details of construction, the substitute must be had in different grades of hardness, toughness, fineness of texture, etc. Moreover the ease of working, sawing, boring, nailing and so on, leads to a wide use of natural wood, and a substitute to be acceptable must approximate the ordinary natural woods in these respects.

Many of the earlier attempts were made in the direction of altering the natural wood by some chemical treatment, so as to make it ignite with greater difficulty and burn more slowly and without much flame. These processes afforded a number of so-called fireproof woods. The principle underlying the chemical treatment was usually one of two. First, the wood was saturated with a solution which, on drying, left in the pores a salt capable of giving off a gas when heated, this gas being of such a nature as to be incapable of supporting combustion. Phosphate of ammonia and tungstate of soda were extensively used for this purpose. With thorough saturation the protection afforded the wood and adjoining portions of the structure was by no means insignificant; specimens of wood treated with phosphate of soda have been in the possession of the author for more than ten years, and after ten yearly tests show no signs of

[1] Published in abstract only. Complete report may be consulted in the rooms of the Society.

deterioration. Similarly some specimens of wood and cloth treated with tungstate of soda in 1903 have shown little or no loss in fire resistance. The main value of such chemical protection lies in its diminishing the volume of the resulting flames. When once thoroughly ignited, the fireproof wood burns more briskly than the natural untreated wood.

The second method of chemical treatment was one in which such substances as alum were used in order to supply a considerable quantity of steam from the water of crystallization and also to encase the pores of cells with a solid refractory substance.

A still earlier procedure was that of protecting wood from contact with a combustion-supporting atmosphere by coating it with thin sheet metal, usually tinned iron or copper. For doors and shutters this was found very effective. More recently hollow metallic members for doors and trim and for furniture have been extensively used, with a considerable degree of success. They are of course non-combustible, and under ordinary exposure keep their shape fairly well.

The wooden lath is without doubt responsible for the rapid spread of fire in many buildings of the older types of construction, and the attempts to develop a substitute have resulted in the metal lath and in the so-called plaster boards. The former are eminently satisfactory as substitutes for wooden lath, their greatest defect being their liability to become weakened by corrosion in damp places when used with certain kinds of plaster. The plaster boards are made of plaster of paris and some fibrous binding material, often wool, hair, or jute. Some are made of superposed layers of wool, felt and plaster. All, however, contain so large a percentage of plaster or other non-combustible material that combustion proceeds very slowly.

There have been from time to time, in the last 30 years, attempts to make use of boards composed only of refractory, inorganic substances. In general, such boards have been composed of some fiber and a cementing medium. The most popular fibers for this sort of experimentation have been asbestos and mineral wool, the cements used including about all the common cements of both the air drying and the hydraulic types. Oxychloride of magnesium, the value of which as a cement was discovered some 50 years ago by Sorel, has been the favorite cement for experimenters because of its simple preparation, its quick hardening and great strength. For some reason, however, a large percentage of the oxychloride cement is variable in its properties and often defective. When mixed with

sand or similar dense bodies the oxychloride is often satisfactory for long periods, but the experience of the author with mixtures of this cement with fibers, both organic and inorganic, leads to the conclusion that it is unstable and unsatisfactory. This is more probably the case when the boards are used in damp places or out of doors.

There next appeared a number of wood substitutes in which a fiber was bonded by silicate of soda, commonly known as waterglass. Some were made in this country, but the most serious attempts were made in England and Russia, where the Imshenetzky process was used to make a board called uralite. It was the most satisfactory substitute for wood which had appeared up to that time. Uralite was composed of a sheet of asbestos millboard saturated with a solution of silicate of soda, which was subsequently precipitated as colloidal silica by a solution of bicarbonate of soda. For some reason not connected with the physical or chemical properties of the material, uralite has practically disappeared from the market. There have appeared from time to time a number of patents for boards composed mainly of fibers and lime, but no great use seems to have been made of them.

After much study two conclusions seemed inevitable to the author: First, no homogeneous inorganic substance was likely to prove satisfactory, but that a mixture of a fiber and a cementing substance was necessary to give wood characteristics to the material; and secondly, a mixture of asbestos fiber with one or two cements (first oxide of magnesium or calcined magnesia, and second calcium silicate and aluminate mixture) seemed more suitable than any other combination.

The author proceeds to describe what he calls asbestos wood made under his patents and developed from the application to mixtures of certain processes of mixing, pressing and curing. It is stated to be practically incombustible, harder than natural woods, to have a transverse strength about two-thirds that of white pine with the grain, and, without being brittle, an elasticity less than that of natural woods; the coefficient of thermal conductivity has been found in English units to be between 50 and 30 B.t.u. per sq. ft. per 24 hours, per 1 deg. fahr.

The weight of the several grades of asbestos wood 1 in. thick varies from 8 lb. to 13 lb. per sq. ft. White pine 1 in. thick when dry weighs approximately 3 lb. per sq. ft., and oak about twice as much. The transverse strength of boards and the maximum fiber stress is between the limits of 5,000 lb. and 10,000 lb. Test speci-

mens 12 in. wide, 12 in. long and $\frac{1}{4}$ in. thick, broken by center load when supported on two edges with 11 in. span, broke on an average at 200 lb. load. Under the same conditions clear white pine broke under a load of 300 lb. with grain and 20 lb. across it. In some cases the equality of strength in both directions is of great advantage.

The tendency of the material to absorb water varies between the limits of 4 per cent and 20 per cent. This absorption is not of such

FIG. 1. STORAGE OF ASBESTOS WOOD

a nature or amount as to cause disintegration from freezing and the material is not injured by prolonged soaking in fresh water. Sea water tends to disintegrate it after a time, the magnesium salts in the water replacing the calcium of the cement.

The coefficient of expansion varies with the temperature and also with the age of the specimen. It is small, being about 0.000004 at ordinary temperatures, diminishing rapidly at 700 deg. fahr. and becoming negative at 950 deg. fahr. where shrinkage occurs.

The operations of boring, sawing and finishing are all somewhat more difficult with asbestos wood than with the natural woods. It withstands scraping and rubbing much better. Floors and stair treads made of the material wear well, but are liable to be slippery when wet.

Many of the common wooden details of modern buildings have

been successfully duplicated in asbestos wood, doors usually being hollow to save weight. Wherever there is danger of ignition of wooden framework a lining of the material has been found effective, notably in the vicinity of electric apparatus. It has been found best to mold the sheets while still in a plastic condition so as to form large pipes or ducts, and many locomotive round-houses have been equipped with smoke jacks or ventilating hoods. Shingles which

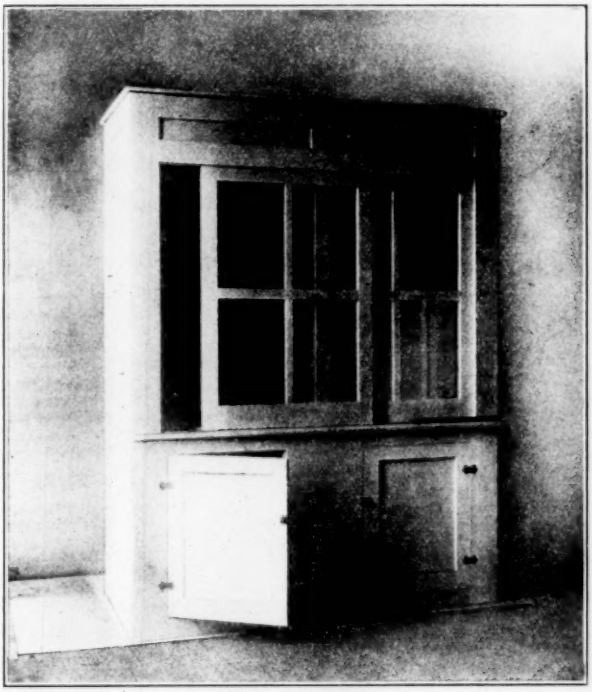

FIG. 2 CABINET OF ASBESTOS WOOD

have been in the weather for years have proved durable and this quality seems certain to equal that of fire resistance.

The ability to stand heat makes it available for blocks on friction brakes where a flexible material is not needed. The coefficient of friction of iron is approximately 0.3 to 0.4.

It has also been used as a mold for glass utensils during the process of manufacture, its non-conducting properties making it preferable to iron in some instances.

It is, of course, the fire resistance of the asbestos wood which gives it its greatest interest. There is nothing combustible in it, and on exposure to fire nothing can occur except a gradual dehydration of both fiber and cement. Under prolonged red heat the boards become weakened, but for such exposure as occurs in fires in buildings the resistance is ample. For instance, a sheet of $\frac{1}{4}$-in. asbestos wood may be placed over the top of an open furnace at 1700 deg. fahr.,

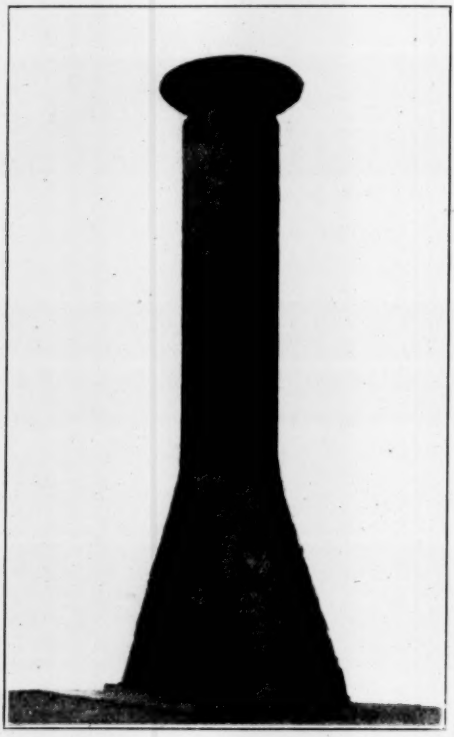

FIG. 3 STACK OF ASBESTOS WOOD

the flame impinging directly on the lower surface of the sheet, and at the end of half an hour the sheet may be taken off and while its lower side is still white hot be plunged into cold water and then returned to the furnace for 10 minutes. It may be slightly warped and its strength will probably be diminished 25 per cent or more, but it will still be sound and whole and free from cracks or serious weakness. Fire tests have shown the ability of the material to withstand much longer exposure, but it is not suitable for linings for furnaces or

kilns which are kept constantly at red heat. In some fire tests the paint on the outside of an asbestos wood door $1\frac{1}{4}$ in. thick was not scorched after the fire inside had been burning at a temperature of 1700 deg. fahr. for more than an hour. Fig. 1 shows the method of storage of the material and Figs. 2 and 3 two of its applications.

DISCUSSION

In the discussion which followed the reading of the paper, F. E. Cabot [1] emphasized the general necessity of making more extensive use of fireproof material in building construction and considered the tin-clad fire-door, properly made, better than any other form of protection yet available. He would welcome the use of fireproof material especially for roofs and trimming.

W. L. Puffer [2] recently had occasion to have designed certain structures which were fireproof and on which he could have high potentials. Among other things tried was asbestos wood. The carpenter found that it was a good thing, but rather rough on tools; fastening it in place also proved difficult, because neither wood screws nor boring a hole and tapping it would do, and the block could be held in place only by cutting a groove along the edge and bolting it in. As a material for use in electrical work, asbestos wood will not handle the electric arc problem, although it will stop comparatively large flashes.

F. F. Jonsberg [3] advocated the use of fireproof construction from an investment point of view, but said that he generally had trouble in persuading architects to use either concrete or asbestos shingles, because they said they could not secure as artistic an effect as is possible with the usual materials.

F. A. Waldron pointed out that with the existing methods of enforcing the building law in some cities, the question of comparative cost of fireproof and non-fireproof construction was often the deciding argument, and he would like to have more data as to that.

H. F. Bryant [4] mentioned his experience with making doors of a refractory substance which he would not call by name; the doors were heavy, mechanically weak, and generally unsatisfactory.

L. S. Cowles [5] thought the question of cost, entirely neglected by Professor Norton, fully as worthy of scientific consideration as, for

[1] Engineer, Boston Board of Fire Underwriters, 55 Kilby St., Boston, Mass.
[2] Consulting Engineer, 201 Devonshire St., Boston, Mass.
[3] Contractor and Builder, Old South Building, Boston, Mass.
[4] Engineer, 334 Washington St., Brookline, Mass.
[5] Assistant Designing Engineer, Boston Ry. Co., 101 Milk St., Boston, Mass.

example, the method of combining and treating suitably the materials which made up the finished product.

F. B. Sanborn [1] wrote that wood served fairly well for fire-resisting purposes when properly embodied in building construction. For floors and roofs two elements were in favor of wood, cost and sufficiency, and, until further changes came about, there did not seem to be any reasonable way to check the present excessive construction of wooden buildings. There was, however, a great and growing demand for a fireproof material to be used for such special purposes as construction of heater rooms, furnace casings, smoke ventilators, and if asbestos board could be adapted to these purposes, there would certainly be an extensive demand for it.

E. V. French wrote that cases often arose where a fireproof building was desired quickly, or where conditions made the use of metal lath and plaster, otherwise satisfactory, inconvenient. A reliable substitute for wood which could be easily worked and which would give a durable and fire-resisting structure, would be of value in such instances. Corrugated iron was often used, but in case of an outside fire, heats through very quickly, and was not durable. It was desirable to appreciate, however, that incombustible construction did not make a fireproof building because in many cases there would inevitably be a great deal of burnable material in the contents, and such conditions could be made safe only by the use of automatic sprinklers.

L. H. Kunhardt emphasized the necessity of avoiding continuous hollow or concealed spaces in building construction, when fireproof material was nailed on to wooden posts or uprights in partitions, etc.

In his closing remarks Professor Norton stated, that although fire doors of large size break, he made doors, and they were growing in size. Asbestos wood required special although not very different treatment for use in switchboards, and had the advantage that even if very great heat drove out the insulating compound, the asbestos was left, and electric fittings stayed in place.

He also spoke of the series of thermal transmission tests being made with all building materials, concrete, wood, paper, carpets, etc., a good deal of the expense of which was being borne by the American Academy of Arts and Sciences. Professor Norton expressed the hope of being able to present the engineering features of this matter to the Society not later than next June.

[1] Professor Civil Engineering, Tufts College, Tufts College, Mass.

POWER SYSTEM OF THE PACIFIC MILLS

On October 18, a meeting was held in Boston under the auspices of the Boston Society of Civil Engineers, in which the Boston section of the American Institute of Electrical Engineers and The American Society of Mechanical Engineers coöperated. The paper of the meeting, by Fred A. Wallace, describes the power system recently installed to supply electric current for power and lighting to the cotton, worsted and printing departments of the Pacific Mills at Lawrence, Mass.[1]

The Pacific Mills Corporation operates several properties; the largest of which is the group of mills and works on the north side of the Merrimac River at Lawrence, Mass., motive power for which has in the past been obtained from a variety of steam engines supplemented by waterwheels. Recently a powerhouse with turbo-generators, concrete coal pocket, etc., has been provided, and an electric transmission system extending throughout the property. The paper includes a description of the plant, transmission system and motor drives, as well as of the methods and organization for operation and inspection, and considerable information as to costs. An interesting feature was the reference to a double walking beam Corliss steam engine, built in 1847, to take steam at 30 lb. gage, and running 30 r.p.m., which in its later years of service has been run on exhaust steam from other sources. This engine was purchased as a high-pressure, high-speed machine.

Under the old arrangement there were at the upper mill, two 28-in. by 48-in. Buckeye engines of 750 h.p. each connected to four waterwheels; also the old Corliss engine geared to four other vertical waterwheels. The jackshaft of both sets of waterwheels was connected by belt transmission through the several floors of the seven-story mill to different departments and by long lines of shafting and gearing to the print works.

The displacing of these belts and shafts by electrical transmission made room for much extra machinery, besides improving general conditions of cleanliness and fire risks. A great many sets of large

[1] Published in abstract only. Complete report may be consulted in the rooms of the Society.

bevel and spur gears were also removed by this change, which increased the general efficiency, as well as eliminated a great deal of noise and mechanical troubles.

A Rice and Sargent cross-compound 800-h.p. engine was removed from the lower mill, and this load as well as a large overload from the remainder of the power system was transferred to the new central station. The Corliss engine, designed over 60 years ago, was also torn down. This engine had two vertical cylinders 38 in. by 84 in., both operating condensing. The flywheel was a gear 20 ft. in diameter and 18 in. face, driving a pinion on the waterwheel jackshaft. In general appearance it was like the famous "Centennial Corliss," but not so elaborately finished. It was built by Nightingale, Bancroft & Company, of Providence, R. I., and was one of the first engines in which George H. Corliss was interested. It was made before the Corliss rotary cut-off valve was introduced, and the speed was controlled by a throttling governor.

In 1897 this engine was overhauled and the valves adjusted to run on low-pressure steam, which was taken from an exhaust system into which nearly 100 engines and pumps of various sizes exhausted. Enough of this exhaust steam was used by the engine to produce about 350 h.p. and the remainder was used for manufacturing purposes. This engine was one of the first large power units to run on exhaust steam.

No tests were made to determine the economy of this arrangement, but it must have been good under the conditions. In changing the engine to run at low pressure and with high vacuum it was realized that there is as much energy given up by 1 lb. of steam expanding from 0 lb. gage pressure to 27 in. vacuum as when expanded from 150 lb. to 0 lb. gage. This shows the great energy stored in steam at low pressures, but which cannot be utilized with a cylinder and piston on account of prohibitive proportions. This is the field now being taken by the low-pressure turbine, which promises to make great improvements in economical power generation. Recent tests indicate that the turbine is making the largest gains in economy since the great changes brought about by the Corliss valve and the expansive use of steam.

In place of the earlier miscellaneous power equipment, it was decided to build a central power plant, which is one of the largest isolated steam-turbine stations devoted entirely to the textile industry, and to adopt electrical transmission. The water power is used in connection with the power from this central station, the

wheels being connected to generators which run in parallel with the rest of the system. The water power is developed in two places, east and west wheel pits, each having two 39-in. and two 36-in. Hercules wheels, direct-connected to generators. That for the east pit is 800 kw. capacity and for the west pit, 600 kw. Although there are four wheels connected to each of the generators, it is customary to run only two, except in times of high back water. The marked advantage of this system is that the power can be supplied to any department for overtime work, as water can be used 16 hours a day without extra cost.

The new power station is located on a $3\frac{1}{2}$-acre lot adjacent to the main line tracks of the Boston & Maine Railroad, about $\frac{1}{4}$ mile from the upper mill, and sends current at 2300 volts to four centers of distribution, the farthest of which is over $\frac{2}{3}$ mile away.

The plant consists of a building for the boiler and turbine room, and a separate coal pocket. In the boiler room are twenty-four 72-in. by 21-ft. 6-in. horizontal, multitubular boilers, arranged in six batteries of four boilers each, 12 boilers being on each side of the firing floor. This floor space is 24 ft. wide, and on a level with the yard and the turbine room basement.

Steam leaves each boiler by a 4-in. pipe, and passes through Foster superheaters set in the rear of the combustion chamber, before entering the main line for distribution. All are connected to a 10-in. main steam header from which steam passes to the different turbines and auxiliaries.

An ingenious arrangement for supporting the steam header is that of a steel-yard arm held at the ceiling, and carrying weights to balance the load of the pipe and fittings. The piping was installed in place with all its fittings, but not connected to the boilers. The weights were moved exactly to balance the entire system, some levers requiring much more than others. When adjusted, the branches were all bolted to the boilers, and the entire line was supported without any strain.

In order to secure the highest efficiency from the superheat, the steam travels through the piping at an average velocity of 7900 ft. per min. The turbines are supplied with steam at 150 lb. boiler pressure, 125 deg. superheat.

Feedwater is furnished by duplex steam pumps from the condenser discharge, at about 75 deg. fahr., through an exhaust steam heater which raises the temperature to about 200 deg. fahr. This heater condenses the exhaust steam from the auxiliaries of the station.

Each group of 12 boilers has a chimney 9 ft. inside diameter by 200 ft. high, built of common red brick. Each chimney is constructed with a separate red brick core wall, which takes the heat of the gases, and allows for expansion and contraction.

The turbine room is equipped with Allis-Chalmers steam-turbine generating sets, and as the station now stands it contains two 3250-kw. and two 750-kw. steam turbines with jet condensing outfits; two motor-driven exciter sets; one steam-driven exciter set, and one 75-kw. engine-driven alternator, with exciter. A small motor-driven centrifugal pump furnishes all pressure water for the station.

Under the turbine room is the basement, containing all the boiler-feed pumps, condenser apparatus, fire pumps, heaters, etc.; and below the basement is a cistern connected to the river, about 1000 ft. distant by a 48-in. penstock. This well supplies water for condensing and all other uses about the station. The condensing water is raised in temperature from 15 to 20 deg. fahr. in passing through the jet condensers, and is then returned to the river through a conduit. The river water is nearly 32 deg. during the several months of the winter and reaches a maximum of 85 deg. in the summer.

The air for cooling the turbo-generators is supplied through a shaft extending above the roof, next to the chimney. The dirt is filtered out by a series of 12 bags of cotton cloth. These bags are cleaned every three months, and about 6 quarts of dust is collected containing considerable carbon, evidently from passing locomotives. The small quantity is probably on account of the height of the entrance from the street.

The current is sent from the station at 2300 volts through lead-sheathed cables, in vitreous conduits underground to four main divisions: (*a*) upper mill power and light; (*b*) yarn mill lighting; (*c*) lower mill power and light; (*d*) the new worsted power and lighting.

The current is stepped down as required for use in the different departments, but in the new worsted mill all are 2300-volt motors. The current from the waterwheel generators is transmitted at 550 volts. The 75-kw. alternator mentioned in the turbine room is used for supplying the current for the yard lights, which are on all night, and for other small uses. A separate transmission circuit was installed for this set, in order to avoid using the large transformers.

The following figures are for cost of operating, an average week, on 3600 kw. These are the conditions under which we have been operating for the last year:

Turbine room labor, 5 men and superintendence	$99.85
Boiler room labor, 8 men	99.15
Fuel at $4.25 per long ton, in pocket	880.00
Oil, waste, supplies and repairs	37.05
Total operating expenses per week	$1116.05

During the week, 204,780 kw-hr. are generated, giving a cost, per kw-hr., of 0.545 cents. The load will soon be increased, due to putting all of the new worsted mill into service, and there will be required approximately 340,000 kw-hr. per week. The normal operating condition will then be to run the two large turbines, leaving the two smaller ones as spares. To operate the station under these conditions will cost:

Turbine room labor, 5 men and superintendence	$ 99.85
Boiler room labor, 9 men	108.95
Fuel at $4.25 per long ton, in pocket	1483.25
Repairs and supplies	58.60
Total operating expenses per week	$1750.65

Operating cost per kw-hr. equals 0.515 cents. The station as it now stands, 8000 kw. normal capacity of generators, costs, with land and everything, up to and including the switchboard, a little less than $90 per kw. Figuring the fixed charges on this at 11 per cent, we get 11 per cent $\times$ 720,000 = $79,200 per year, or $1523.08 per week, and 1523.08 divided by 340,000 equals 0.448 per kw-hr.

The total cost, then, per kw-hr. at the switchboard for the 6100 kw. load on the plant would be

Operating expenses per kw-hr.	0.515 cents
Fixed charges per kw-hr.	0.448 cents
	0.963 cents

The same figures, if this plant should be operated at its full capacity of 8000 kw., as is quite customary in textile mills, would be

Operating charges per kw-hr.	0.501 cents
Fixed charges per kw-hr.	0.340 cents
	0.841 cents

Analyzing these costs for the operating conditions of 6100 kw., it is found that a percentage of the total cost of

	Per Cent
Labor	6.4
Fuel	45.5
Repairs and supplies	1.8
Fixed charges	46.3

These figures show plainly that less fixed charges and better fuel economy are the items which may result in a considerable saving. While economies might be effected by more expensive and efficient apparatus, it must be remembered that the more complicated apparatus invariably requires more expense of repairs and depreciation. The principal object in view in the design and operation of this installation has been simplicity and reliability. Many of the requirements supposed to make for refinements in efficiency have been omitted.

There is still some engine power and pulley and belt transmission used in the plant, which is gradually being superseded by electric power. When the old mills were changed from engine to motor drives a great amount of shafting and belting was removed, and this in itself is one of the motor's best recommendations, not mentioning the flexibility of service, ability to check power required at any time, increased production due to uniform speed. We have, however, no accurate way of knowing whether the total power of the mill is more or less with the electric driving than with the old system, as a great deal of the textile machinery was changed at the same time as the power system.

ELECTRIC PROPULSION OF SHIPS

At the meeting of the Society held in Boston on December 20, 1911, with the Boston Society of Civil Engineers and the Boston Section of the American Institute of Electrical Engineers, W. L. R. Emmet gave a talk on Electric Propulsion of Ships.[1]

Many persons familiar with turbines and modern turbine development are not familiar with ships; many of the people familiar with turbines are not familiar with large turbines; and many of both classes are not familiar with electricity. Hardly anybody but the author and about two people in England have really come out as advocates of the electrical propulsion of ships. Mr. Mavor [2] has devised many schemes for electrical propulsion and has brought forth very many fruitful facts about it and aroused considerable interest; but generally speaking the electrical propulsion of ships has attracted no great attention and has at present very few advocates; this is largely to be attributed, in the author's opinion, to lack of knowledge of the matter, as well as to the fact that shipbuilders all over the world are unfriendly to electric propulsion, presumably because it robs them of the building of the engines.

The large marine engines of today are limited in many ways by the dimensions and practicabilities of the case, valve areas, cylinder volumes, etc., so that it is not uncommon to find that in ships the largest engines are not the best. In the application of electric generators with turbines exactly the reverse is the case. The largest unit is the best within the desirable limit of speed, and the only limit to the size of the turbine is the size of parts which can be handled and shipped; and as the size goes up, the efficiency improves, and weight and cost per horsepower diminish. When applied to small vessels the comparison of electric propulsion with other methods is not very attractive, but becomes wonderfully so in large vessels.

After considerable trouble the General Electric Company obtained from the United States Government an award to equip with

[1] Published in abstract only. Complete report may be consulted in the rooms of the Society.

[2] Glasgow, Scotland.

electric propulsion the collier Jupiter, a ship of about 20,000 tons, giving 14 knots, and now being built at the Mare Island Navy Yard. Even such a ship is only moderately adapted to electric propulsion, for the reason that the power required in it is not large enough to make the best relative showing. Electric propulsion is really well adapted to very large vessels, particularly those of moderate speed to which the turbines are not directly applicable.

The author proceeds to compare the collier Jupiter with its sister ships, Cyclops and Neptune, the former of which was equipped with marine steam engines and the latter with a steam turbine and reduction gearing, and shows that even in such a vessel electric propulsion has important advantages. The collier Cyclops, built by Cramps and equipped with very fine triple expansion engines, required about 6800 shaft horsepower to make 14 knots, and her engines weigh 335 tons, not including the weight of galleries and structures. An equivalent equipment on the Jupiter has an overall weight of only 145 tons, and besides takes up very little room. The author does not know the steam consumption of the Cyclops, but takes it to be $14\frac{1}{2}$ lb., which is extremely good for this class of vessel, while the equipment on the Jupiter, basing the calculation upon a generating unit which has already been run and tested under similar conditions, will deliver 12 lb., giving at least $2\frac{1}{2}$ lb. better economy. Furthermore, this equipment is ideally simple and compact. It is the simplest form of electrical transmission which is known, and it possesses the advantage that in this case the power is not taken from a great reservoir of power, but just as much electricity is made as needed, and the generator is at no time capable of delivering, even on a short circuit, very much more current than ordinarily passes to the motor. The voltage is low and the windings are of the simplest type.

The collier Neptune was recently run with turbines and gearing. The gearing worked successfully, as the author understood, but for some reason the turbines were run at low speed and the propellers at high speed, higher than they should, with a very poor result in economy. The Cyclops made in her trials 14.6 knots with the propeller running about 94 r.p.m., while the Neptune made 12.9 knots with the propeller running about 135 r.p.m. The author thinks that the fault lies in an unsuitable selection of speed, and that better results may be obtained with other turbines and different propellers, but that the results will never be as good as with electric propulsion.

The application of the turbine itself to marine propulsion, while

it has an enormous field, is a difficult matter, because the turbine is seriously handicapped by the necessities of propeller speed, and it is only in the very largest and fastest vessels that the turbine finds a good application. In a vessel like the Lusitania the speed of the ship is so great that she can run at a very high propeller speed with fair efficiency, and consequently her turbines, on account of their enormous size, are at a pretty nearly desirable speed. Since the propulsive coefficients of many of our large turbine-driven battleships are below 50 per cent, that is, the ratio of power delivered to the propellers to the power which would have to be delivered to a tow-line to pull that ship through the water. The losses which concern us in electrical processes are very small in comparison with these great inefficiencies of the propeller, so that we cannot change the propeller speed much without risk of losing all the advantages of whatever we are using.

The author considers the Jupiter turbine the highest development of the Curtis turbine to date. It is carried through one very high-speed stage down pretty well in pressure. There is something like 80,000 ft-lb. of work in this stage. From there on there is a continuous admission. Another feature of this machine is that every bucket is accessible, so that the top can be taken off, the nozzle parts removed, and any bucket can be taken out and replaced without taking the shaft out of the turbine. There is an upward steam delivery which connects up to the condenser. This unit is equipped with a governor designed with a characteristic very different from that ordinarily used in speed governors. It is designed so that by a certain setting of the levers connecting from the governor to the valve operating mechanism, the governor can be made to control the speed at any point from full speed down to something less than one-quarter speed, and it will hold it within 1 or 2 per cent no matter how the wind blows. Furthermore, there is an arrangement entirely apart from this engine adjustment, by which the speed control dial can be moved by electrical action from the bridge.

The Jupiter motors are simple induction motors of low voltage, of what would be called M-type, having collector rings and brushes by which a resistance can be put into the circuit of the rotor. Normally a slider short-circuits the collector rings, so that the motor is closed upon itself, and there is no current passing in the collector rings. There is an external resistance which, when this slider is withdrawn, is in the circuit, and the introduction of that resistance gives the power of exerting a high torque irrespective of the speed of the motor,

as well as a large reversing torque. Under these conditions the amount of energy delivered to the resistance is very large. The author has devised a novel resistance for that purpose. In very large ships no changes of connection would be made when the circuit is alive. The field of the generator would be opened and the circuit killed before changing the connections, and all these would be interlinked by magnets so that the field could not be moved. In ships of the size of Jupiter it is easy to change the circuit while alive, with no fear of endangering any of the contacts.

Whenever the question of electrical propulsion is mentioned, propulsion by gearing naturally invites comparison. The latter is as yet merely problematic, because nobody knows yet what the safe limits of application of high-speed gearing are. There are, however, very good reasons for supposing that gearing is not the best method of propulsion for very large ships. There is at present one ship, the Vespasian, being successfully propelled by gearing, the equipment of which was designed by Sir Charles Parsons. The Vespasian is a vessel of one propeller, about 10 or 11 knots, with propeller speed of about 75 r.p.m. The turbines are divided into two parts, and the larger gear is driven with two pinions. These pinions are only about 5 in. in diameter. The large gear is about 8 ft. in diameter, so that the speed reduction is 20 to 1. Each of the two pairs of pinions delivers only 500 h.p.

This gear has worked and has given a very fair showing; it has given a somewhat better efficiency on the Vespasian than an engine could give her, but it would be a very different thing to apply the same method to a ship where one has to deliver 17,000 h.p. instead of 1000. Should we apply more power to one of these double pinions 2 ft. long, the torsion of that long bar would be sufficient to give the whole bearing on one end of one of these pinions. It would not distribute itself, and so we are limited in power by the stiffness of the pinion shaft and the pinion itself. It must be rigid, because if it twists a little, the teeth do not engage properly. Therefore to put more power in it, to make it stiffer, its diameter has to be increased, and to keep down the pressure on the teeth, the length must be increased. But as soon as we increase the diameter, we have to decrease the turbine or the propeller speed or increase the diameter of the large wheel, which is already 8 ft., and that involves a further difficulty of maintaining a perfect working position between centres many feet apart in the ship. The difficulties of high-speed gearing increase with the size, like a gas engine,

and if any is distorted, even the very slightest degree, there will be a blow like that of a projectile striking an armor plate. Until some improved method of running gearing is adopted, the propulsion of the 1000-h.p. Vespasian means nothing in connection with the question of the propulsion of steamships on trans-Atlantic lines, while in the Neptune the propeller speeds are far too high, and the turbine speeds far too low. In the electric propulsion of the Jupiter the speed used on the turbine is 2000 r.p.m., and there are two propellers running at a speed of 110 r.p.m., which was the speed selected by the officers of the Navy Department as the most desirable, so that both the propellers and the turbines are driven at the best speed.

The talk was illustrated by numerous slides.

DISCUSSION

In the discussion which followed, Prof. Ira N. Hollis described the use of gearing in a ship on a large scale as early as 1866. It was a ship designed originally to catch the Alabama. The reason for putting the gearing in was the desire to drive the propeller at 75 r.p.m. by a reciprocating engine of low speed making 30 r.p.m. The ship was tried and run for 36 hours at full speed, with the result that the gear was too much worn to be thought reliable in a sea afterward. Gearing is made a great deal better now, but Professor Hollis stated that nevertheless he has comparatively little faith in the results.

Prof. C. H. Peabody [1] pointed out that until somebody invents an entirely different method of propulsion, the coefficient must be low, as the efficiency of the propeller is between 65 and 70 per cent, and this is due to the fact that it is necessary to have some form of propeller entirely external to the ship.

Mr. Emmet finally stated that the frequency used in the apparatus varies in different cases. In the case of the battleships the maximum frequency is about 40 cycles, in the collier Jupiter about 33 cycles, and a little below 30 in the other large vessels of which Mr. Emmet spoke, but the frequency diminishes with the speed, the turbine slowing down with the ship. The whole subject of electric ship propulsion is very much limited by the matter of frequency, for the reason that a generator cannot be built with less than two poles. If generators could be made with

[1] Professor Naval Architecture and Marine Engineering, Mass. Inst. Tech., Boston, Mass.

1 or $1\frac{1}{2}$ poles, slower ships could be driven effectively by electricity, but the difficulty is that high frequencies cannot be used, because with slow propellers an impracticable number of poles in the motors results. Very low frequencies must be used, and this is not possible with high speed in the turbines, because the least number of poles is two. That is one of the principal reasons why electrical propulsion finds its best application in large ships.

NEW HAVEN MEETING

COST OF POWER WITH SMALL UNITS OF VARIOUS TYPES

At a meeting held in the Mason Laboratory, Sheffield Scientific School, New Haven, November 15, 1911, which was the first meeting of the Society in that city, the subject for discussion was the Comparative Cost of Power.[1] The Chairman of the meeting was E. S. Cooley, and several engineers from New York, Hartford and other cities were in attendance, including President E. D. Meier. This meeting has already had a brief notice in The Journal for December 1911.

The first paper on A Small Producer Gas Power Plant in a Wood-Working Shop, by Albert W. Honywill, Jr., gave the cost of operation and working conditions, with a producer plant installed at the Lampson Lumber Company of New Haven. The engine is rated at 45 h.p. at 160 r.p.m. and is of the four-cycle hit-and-miss type, with poppet valves and jump-spark ignition. The producer is of the ordinary suction type, with stationary grates, and the quantity of gas delivered to the engine is varied by a hand-adjusted throttle valve in the delivery pipe. The plant is in operation 9 hours a day, the engine kept running noon hour, and the load variable.

The average coal consumption is approximately 467 lb. of pea anthracite per day, or 46.7 lb. per hour. Assuming an average load factor for the shop of approximately 40 per cent, this is equivalent to $2\frac{1}{2}$ lb. of coal per h.p-hr. The cost of coal delivered is $4.50 per ton, which would give an average cost per b.h.p. per hour of 0.56 cents. No account is taken of the cost of water, as the only cost is that of pumping.

The first cost of the plant, including producer, engine, blower and motor to drive same, was, in round figures, $3500. The operating expenses per day were found to be:

[1] Published in abstract only. Complete report may be consulted in the rooms of the Society.

Coal, 467 lb. at $4.50 per ton	$1.05
Labor	2.50
Repairs and depreciation	1.16
Interest and taxes	0.70
Oil and waste	0.14
	$5.55

The ashes from the producer were, however, screened, and coal secured in this manner may be estimated at $2 per ton, which reduces the real operating expenses to $5.08 per day.

Following the paper by Mr. Honywill, there was a brief discussion, after which a paper was read by E. H. Lockwood, joint author with F. P. Pfleghar[1] on Comparative Cost of Power by an Oil Engine and a Steam Engine. The cost of power of the following engines was compared: A De La Vergne oil engine, horizontal, single-acting, center crank, four-stroke cycle, jacket water-cooled; fuel, petroleum fuel oil at about 3 cents per gal. at the factory; ignition, hot chamber, on the Hornsby-Akroyd system; cylinder dimensions, diameter 27 in., stroke 33 in., rated horsepower 125, used to drive a direct-connected 220-volt generator, the power being used for light and power, and average output being about 90 h.p. The engine was carefully tested for output and fuel consumption and was found to be quite economical of fuel. The steam engine was a horizontal 100-h.p. Putnam engine, and a Fitzgibbons boiler of the same rated boiler horsepower.

ACTUAL COST OF OPERATION OF OIL ENGINE

Fuel oil, 14 gal. per day	$3.78
Labor, half-time of one man	1.50
Oil, waste, water, repairs, per day	1.00
Cost per day	$6.28

Reduced to the basis of 300 days per year, and divided by 90 (h.p.), the above cost amounts to $20.93 per h.p. per year.

FIXED CHARGES FOR SAME ENGINE

Cost of engine and generator, 10 per cent of $6000	$600.00
Cost of heating boiler, 10 per cent of $1000	100.00
Insurance, taxes, etc., per year	250.00
Total fixed charges per year	$950.00
Fixed charges per year per h.p.	$10.55

Combining the two costs, the total cost per h.p. per year, operation and fixed charges, is $30.48.

[1] President Pfleghar Hdw. Spec. Co., New Haven.

ESTIMATED COST OF OPERATION OF STEAM ENGINE

Fuel per day, 2¼ tons	$8.21
Labor, time of one man	3.00
Oil, waste, etc., per day	0.50
Total per day	$11.71

Reduced to the basis of 300 days, and divided by 90 (h.p.), the above cost amounts to $39.04 per h.p. per year.

FIXED CHARGES FOR SAME ENGINE

Cost of steam engine and generator, 10 per cent	$350.00
Cost of boiler, 10 per cent	200.00
Repairs, insurance, and taxes	250.00
Total fixed charges per year	$800.00
Fixed charges per year per h.p.	8.88

The two costs combined give a total cost of 1 h.p. per year, operation and fixed charges, of $47.92.

This showing is favorable to the oil engine, but it must be remembered that the steam engine has a useful by-product of exhaust steam during seven months of the year when the factory must be heated. Allowance can be made for the steam used in this way by deducting the cost of coal required for heating, which, estimated at 1 ton per day on the average for seven months, is about $766. By this credit the cost of power by the steam engine is reduced, but is still above the oil engine, as will be shown by the following summary:

Total cost of power by 90-h.p. oil engine, including labor, fuel, fixed charges, etc.	$30.48
Total cost of power by 90-h.p. steam engine, including labor, fuel, fixed charges, etc., and giving credit for exhaust steam for heating	39.38

Both the above are on the basis of 1 h.p. per day of 10 hours, 300 days per year.

Following the paper by E. H. Lockwood, there was a discussion, after which a paper was read on The Status of Small Steam Turbines by W. J. A. London. He considered that the question of water rate does not cover the real meaning of efficiency; in a small turbine a difference of a few per cent in water rate efficiency means comparatively little as far as the cost of operation is concerned, and if higher water rate efficiency may be attained only at the cost of additional complication and weight, and higher first cost, he thought it would be a mistake always to prefer absolute water rate to commercial efficiency and especially reliability of operation. As regards the

actual water rates obtained, the turbine is not a "steam hog," as shown by a few examples quoted below, but the engineer in practice is more interested in his overall water rate per air, electrical or water horsepower, as the case may be, and in this respect units are now obtainable which can hold their own against all competition, not only in reliability but in actual water rate efficiency. In general, however, where a guarantee made by the turbine builder apparently falls down in actual tests with a blower or pump, it is often found that the fault lies with the pump rather than with the turbine. With regard to the comparative performances of turbine-driven and engine-driven pumps for boiler-feed purposes, some interesting comparisons (Table 1) are obtainable from the tests made on board the scout cruisers Birmingham, Chester and Salem. Together with these figures are given the water rates that are obtainable from the modern turbine boiler-feed pump.

TABLE 1 PERFORMANCE OF RECIPROCATING FEED PUMPS ON SCOUT CRUISERS AND EQUIVALENT PERFORMANCE OF TURBINE DRIVEN SETS

	Steam Pressure, Lb.	Back Pressure, Lb.	Gal. per Min.	Ft.	Water Rate	Equivalent Turbine Water Rate	Improvement, Per Cent
Birmingham	183	6	329	488	83.0	61.8	25.5
Salem	203	6	193	690	91.8	61.2	33.6
Chester	187	6.7	219	610	101.0	64.0	34.6
Average					91.9	62.4	31.2

On reciprocating sets efficiency assumed: pump—85 per cent, engine—90 per cent.

On the general subject of steam consumption of small steam turbines, the writer thinks that Napier's formula might be used to greater commercial advantage than it is at the present time. The majority of small turbines now operate with a terminal pressure at the jet below 0.58 of the initial pressure, so that this formula can be applied to any machine, and the steam consumption determined by placing a gage in the steam ring, the number and size of jets being known. In a series of tests carried out within the last few days, in seven readings with a ring pressure varying from 40 to 150 lb., the maximum discrepancy between calculated and actual results was 1.3 per cent and the mean over all the readings was 0.443 per cent.

The design of the machine should be as simple and the governor and other mechanism attached thereto as fool-proof as possible, even at the expense of efficiency, if necessary, and recent government

tests have shown that the single governor mounted directly on the turbine shaft is sufficiently sensitive for close regulation.

DISCUSSION

In the discussion of these papers Alexis Krah,[1] of New Haven, Conn., said that the bad features of the oil engine are the necessity of heating it up for about 20 minutes before it starts, the expense of frequent renewals of caps, irregular work of the generator when directly connected on the shaft, and higher expenses for keeping up the engine. The engine generally gives more trouble than a steam engine, and in winter is less economical.

Geo. A. Orrok, answering A. D. Risteen's [2] question, said that very little nickel alloys have been used in gas engine construction, and, although in Germany cylinders are made of iron in which the coefficient of expansion is remarkably small, such castings are not produced in this country.

A. E. Greene, of Hartford, Conn., pointed out that whatever source of power as a prime mover we have, we find it necessary to use coal for heating purposes, and one cannot say that one type of prime mover will be satisfactory for all conditions. In New England steam engines seem to give very good satisfaction if all-year efficiency is considered.

W. S. Huson explained the system in use along the canal of the Housatonic River for selling water power by the square foot, and gave the cost of 11 sq. ft., 110 h.p. per year, as $2550.

In discussing the question of efficiency, Mr. Orrok pointed out that his company has about 40 small turbines in service, the oldest ones being five years old, and that as yet not a cent was spent for repairs on them; all the attention they get is that of a man putting his hand on the bearings, once or twice a watch, to see that they are not warm. As regards the water rate of feed pumps, the feed pumps are run at from 0 to 50 per cent of what they can do, and under these conditions cannot be efficient, and do not have to be; if by using a small turbine, the pump can be made simpler and more reliable, that is all that is required.

The chairman called attention to the fact that with a small turbine, even if an accident does occur, due to some fault in installation, it does not have such serious consequences as in the case of a steam engine, and C. H. Norris added that the turbine seems to be the ap-

[1] M. M. Pfleghar Hdw. Spec. Co., New Haven.

[2] M. E., Hartford Steam Boiler Insp. & Ins. Co.

paratus that would serve best under abuse in backward plants with poor engineers. L. P. Breckenridge invited the members to send to the Secretary any specific information they may be able to furnish as regards the cost of power in this locality.

EVENING SESSION

In the evening session, Professor Breckenridge presiding, the president of The American Society of Mechanical Engineers, Col. E. D. Meier, addressed the meeting, telling how the first national society was formed of civil engineers, the engineers of the time; how, with the growth and differentiation of the engineering profession, other national societies were formed, until it seems that now is the time to put a stop to that movement by coöperation. The American Society of Mechanical Engineers is trying to accomplish this by the making of branches, groups or sections in various states, by granting them full autonomy, and by allowing the different sections to call in affiliates. This policy, as President Meier had occasion to see personally in Providence and several places in the West, appears to work very satisfactorily. The sections can do important local work in bringing together the members of the Society with men who may or may not be able to join the parent Society, but may be of use to it as affiliates. The production of papers by the local sections is also a valuable aid to the Society as a whole, and the Society has arranged to help its branches by printing for them at cost papers of local interest, the idea being to benefit not one particular society, but the engineering profession as a whole. In connection with that, President Meier called attention to the proposed celebration of the opening of the Panama Canal, the greatest feat of engineering ever performed by man.

After that Prof. C. F. Scott presented a paper, on The History and Development of the Hartford Electric Light Company. The Hartford plant has welcomed new things, and has always been ready for the opportunity to try new inventions. Professor Scott illustrated by numerous slides how the Hartford plant, always in the lead as to the choice of its mechanical and electrical equipment, has created a central station service supplying one of the busiest manufacturing centers in the country with light, and to a very large extent with power, cheaper and better than the plants could produce themselves.

The chairman then gave a brief history and description of the Mason Laboratory where the meeting was being held.

FACTORY CONSTRUCTION AND ARRANGEMENT[1]

By L. P. Alford and H. C. Farrell, Published in The Journal for October 1911

ABSTRACT OF PAPER

The arrangement and construction of the reinforced concrete factory buildings of the United Shoe Machinery Company at Beverly, Mass., are presented, with reference to their adaptability to the manufacture of light machinery. The advantages and disadvantages of concrete floors are discussed, and the experience of this plant given to show that such floors are satisfactory in the machine shop. The original manufacturing scheme, the one-shop plan, is described, together with the modifications that it has undergone since its inception. The original artificial lighting installation is shown with changes now being made to use the more recently developed higher efficiency lighting units. As the plant has had rapid growth, modifications based on experience have been made as new construction was undertaken, and these changes are traced in detail. Finally, the plant contains one of the first extensive developments in the use of steel storage racks. The design of these is given, together with an account of the conditions under which they were developed and the uniformly successful results in their use are shown.

DISCUSSION

Alexander Taylor (written). In 1885 the Westinghouse Electric & Manufacturing Company had grown to a size sufficient to warrant its occupying the entire set of buildings hitherto shared with the other Westinghouse companies. The buildings could hardly be considered modern, even for those days, and this, together with the fact that the company was constantly extending its lines of apparatus, made it practically impossible to work out in detail any fixed plan of manufacture which would prove equally suitable for all of its products. Following the usual custom of most small and even medium sized manufacturing concerns, the one-shop plan was adopted and an attempt made to arrange the equipment to group together similar machining and other operations, such as planing, drilling, milling, screw machine work, winding, insulating, baking, etc.

[1] Published in abstract only. Complete report may be consulted in the rooms of the Society.

Presented at the New York meeting, October 1911 of The American Society of Mechanical Engineers. All discussion is subject to revision.

This plan has the following advantages:

a For each of the principal operations, there is generally but one expert, and if the limited talent is to be used to the best advantage, no other scheme, such as the output department plan in which the equipment is arranged on the basis of product or output, is permissible.

b The centralization or localization of all equipment of a like kind, tends toward a decrease in the amount necessary for a given volume of work.

c Floor space will be economized.

d Conditions for obtaining best results in accuracy and speed of workmanship will be more nearly approached.

e Uniformity in methods will prevail.

f There will be a minimum distribution of power, etc.

Certain operations in the works paralleled themselves in one or more places, thus approaching to a limited extent the so-called output department plan, and until $3\frac{1}{2}$ years ago conditions were met fairly satisfactorily along lines which may best be described as departmentalization, partly on the basis of equipment and partly on the basis of product or output; or, to describe it in other terms, partly on the one-shop plan and partly on the output department plan.

In a growing concern manufacturing a diversity of product, a time eventually comes when the advantages of the one-shop plan are more than outweighed by other features which enter in and which must be given full consideration. One of the most apparent weaknesses of such a scheme is the increasing inability to fill orders with reasonable dispatch, and this is not confined to special apparatus which requires to be built from the ground up; but, it applies as well to fairly standard apparatus, the more so when the parts are not, for one reason or another, carried in stock. Evidence of this may be seen in the larger and larger number of rush, forfeiture and other special orders being placed in the personally conducted class to be given right of way and railroaded through the shops, regardless of the orders of less fortunate customers, not to mention orders for stock. This method of handling is not a solution of a difficult situation, but rather a makeshift and a course which if followed a sufficient length of time simply adds to the general confusion. Other equally grave defects are the multiplicity of foremen and superintendents concerned in the manufacture of any single class of product,

the increase of clerical and of manual labor due to the volume of semi-finished and finished parts passing between "feeder" sections and from "feeder" to "assembly" sections, and, most vitally of all, the matter of divided responsibility. All of these features result in delays and in increased expenses of various kinds, which cannot be overcome; and it needs but little imagination to conclude that work in progress as well as stocks, raw and finished, will under such a scheme be high and that costs must follow suit.

As a result therefore of study in more or less detail of the plans followed by other large manufacturing companies, the management decided to divide the plant into separate manufacturing units, as self-contained and as independent of one another as the nature of the product of each would permit, believing that without sacrificing any of the essential advantages of the original plan, the difficulties incident to its later working could be largely eliminated and the following features still secured: (*a*) centralization of authority in the production of each class of apparatus; (*b*) decrease in time required to fill customers' orders; (*c*) increase in output in a given period; (*d*) decrease in work in progress and in stocks, raw and finished; (*e*) saving of floor space; (*f*) decrease in handling of materials; (*g*) decrease in clerical labor; (*h*) decrease in indirect expense or overhead burden; (*i*) increase in individual initiative; (*j*) healthy competition between similar sections and departments.

As a matter of caution it was decided to put the proposed plan into effect in but a single department, giving it a thorough try-out on a limited scale. The department embracing the manufacture of railway, mining and crane motors was selected for trial and divided into six sections: field machining, armature building, commutator and brush holders, armature winding, bearings and housings, motor assembling. The equipment was rearranged as well as increased either by the addition of tools from other departments where certain of the parts had previously been made, or by the purchase of new tools. In each of the sections named it was the aim, while grouping the tools together as much as possible according to similar operations, to prevent either a retraverse of the work or too great a traverse. The clerical and accounting features were also changed in keeping with the requirements, so that it would at any and all times be possible to measure within close limits of accuracy the relative advantages and disadvantages of the new move. The most gratifying results were obtained almost from the very start, and nothing subsequently developed to alter the first favorable impres-

sions. Comparing the routine in this department under the original and the modified plans, where formerly the work was performed by no less than 22 sections located in 13 independent departments, it is now done by 13 sections in 7 independent departments. Under the modified plan, authority for the entire line of product was vested in a single individual, who was therefore enabled to exercise his judgment as to the amounts of raw and of finished materials to be carried. By a proper selection of these and with an intimate knowledge of the speed of travel of each class of motors under his supervision, he was enabled to reduce the hitherto wide fluctuations in stocks and to have more nearly the right amount of parts constantly on hand, being at the same time not nearly so dependent as under the original plan, on other sections which supplied him with materials. Shipments were thus not only greatly facilitated, but both work in progress and stocks were decreased in marked degrees.

The very excellent showing made in the department selected for trial, led to the extension of the plan throughout the works until now they may be said to be quite fully departmentalized, at least as far as the manufacturing is concerned, and the general results have been but a confirmation of those obtained in the department first selected for trial. It will, of course, be appreciated that it is not practical to carry out a scheme of this kind in all departments, as in the cabinet shop, pattern shop and foundries; or in other places where either the work or the equipment is very special, as the insulating section, the blacksmith and the punch shops.

As at present arranged there are in the works eight fairly self-contained departments: the railway, for railway, mining and crane motors; the power, for large generators and motors; the control, for railway and industrial control apparatus; the detail, for switchboards and accessories, including line material; the small motor, for small power motors; the transformer; the locomotive; and the industrial, for medium sized motors.

From the accounting standpoint, departmentalization has been carried even further than it has on the manufacturing side, since practically every part of the works, regardless of whether it is a feeder section or a departmentalized unit, has been thus treated, giving a total of 53 such divisions. All accounts are balanced monthly. Each division has its own percentage of overhead burden; and as it is not the aim to show either a profit or a loss the percentages are altered as occasion makes necessary.

A set of charts is provided each division every month, showing a continuous record of its past performance along various lines, as total productive labor, total expense labor, total expense materials, these items in turn being subdivided in helpful ways.

Departmentalization on the basis of product or output has also been extended to the engineering, and, in rather lesser degree, to the sales department. In some instances the engineers and the sales correspondents are located alongside of one another, in order to facilitate as much as possible the routine work in connection with orders.

It will be recognized from the very brief description here given of the present plan of working at the East Pittsburgh plant of the Westinghouse Electric & Manufacturing Company, how difficult it would be to set forth rules for the guidance of others passing through a similar condition and, therefore, no attempt has been made to do so. It is furthermore not asserted that the plan outlined is the only correct way of operating a large and growing manufacturing concern; but, from the experience of the management and as borne out by certain recently published statistics, it is quite evident that it is the best course that can be prescribed for present requirements.

C. E. CLEWELL [1] said that there were three methods by which artificial light might be furnished: (*a*) the units used as individual lamps close to the work, one lamp being provided for each machine; (*b*) all the lamps mounted above the heads of the workmen, thus providing distributed light units over the entire floor space; (*c*) a combination of the two foregoing methods, that is, a small amount of general lighting supplemented by individual lamps over the various machines.

It is best, where possible, to do away with drop lamps and to install enough lamps mounted high and out of the ordinary field of vision to light the place properly. With the overhead system of lighting the entire floor space is lighted and the workman is not confined to a small spot of light cast by a drop lamp. All glare and dazzling effect may be avoided, as well as that fatigue of vision produced, in the absence of overhead light, by a constant traveling of the eye from the intensely lighted spot under the drop lamp to the considerably darker surroundings. The overhead system is also more economical, more pleasing and neater in appearance than where drop cords are used. There may be, however, some cases

[1] Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

where drop lamps are essential. This is notably the case with die-making, milling machines, and so on.

The adaptability of a certain quality and quantity of light to certain conditions is a test of time. Eye-strain and even permanent injury may result from the use of a given kind of light which, through ignorance, may seem fairly satisfactory to the user. In practice scarcely two locations will be found exactly alike. This makes necessary a careful study of nearly every case by the designing engineer.

Attention must be given to such points as the intensity of the light, its uniformity, and the reflectors to be used. These last are now designed in a scientific manner for distributing the light evenly over the floor space, a very desirable feature in manufacturing locations well filled with workmen, since a constant shifting of the work calls for light of equal quantity at any point where work is apt to be performed. Other items are the elimination of drop lamps in all but exceptional cases; the avoidance of the bright light shining from the lamp into the eye, or the glare, which is both harmful and annoying as well as inefficient in that it reduces the effectiveness of vision by a partially blinding tendency; the use of lamps of sizes which are consistent with the ceiling height, that is, where the ceiling is low, small lamps should be used and vice versa; in connection with incandescent lamps, reflectors which are scientifically designed must necessarily have the lamp filament at a particular point in the reflector in order to realize the highest efficiency, and for this reason the proper reflector holder should always be used.

The side light in overhead systems is often as important as the light thrown vertically downward by the lamp and reflector. The idea that the excellence of light is in proportion to the quantity is a mistake. Too much light may often be even more harmful to the eye than too little. None the less troublesome is the effect of lamps spaced too far apart, producing eye-strain and rendering the performance of good work impossible.

The wiring should be so arranged that the lamps may be controlled economically by fairly numerous switches, and that not too large an area of floor space is lighted by the lamps of each circuit; this allows certain lamps to be turned off when not required.

A maintenance department is an excellent way of taking systematic care of all the items associated with the upkeep of the lighting system. The lamps should be renewed as soon as burned out, or trimmed when necessary, and the reflectors and globes cleaned at

sufficiently short intervals to insure an average condition of high efficiency. Large losses of light, as great as 40 to 50 per cent in the worst cases, are recorded due to accumulations of grease and dirt on glass reflectors and, as it would cost comparatively little to have them clean, there is no cause for the neglect of this item.

From the manager's point of view, good lighting is important because it helps towards greater accuracy of the work, the saving of the eyes, brighter and more pleasing surroundings, reduction of accidents, and the like. These items while difficult to estimate in money values really form the most important features connected with the problem.

As illustrating the small differences between good and inferior lighting the following hypothetical case is set forth, the conditions being, however, very nearly those of actual cases in existing machine shops. Making certain assumptions in the case of tungsten lighting as to energy cost, life of lamp, cleaning, interest, depreciation, etc., the annual operation and maintenance cost for a typical factory bay 16 ft. by 40 ft. may be taken as $50. Such a bay will accommodate say five workmen. If the wages of these men equal, say 25 cents per hour, the gross wages of the five men per annum may equal $3500. Adding to this the cost of superintendence and indirect expense, the gross cost of such a bay may equal $5000 to $7000. In such a case the lighting will cost $\frac{7}{10}$ to 1 per cent of the wages, or the equivalent of less than 4 to 6 minutes per day. Poor lighting will presumably cost at least one-half of this amount or the equivalent of 2 to 3 minutes per day. If therefore good light enables a man to do better and more work to the extent of 2 to 3 minutes per day, the installation of good lighting instead of poor will pay for the difference in cost. The usefulness therefore rather than the expense should be the leading thought and more progress may be looked for in the future if the shop manager will gain this attitude toward illumination as an aid to factory production rather than center all thought, as in the past, on the first outlay or the yearly expense.

G. H. STICKNEY [1] discussed the various methods of illumination. A few years ago there were two distinctly different methods, general illumination by arc lamps, and localized illumination by carbon filament incandescent lamps. The tungsten filament incandescent lamp, providing as it does a range of efficient units throughout the gap in capacities between the arc and carbon filament incandescent lamps, has led

[1] Electrical Engr., Genl. Elec. Co., Harrison, N. J.

to the creation of four classes of shop lighting, namely, (*a*) localized illumination with small lighting units; (*b*) general illumination with large lighting units; (*c*) combined localized and general illumination with both small and large units; and (*d*) localized-general illumination with units of intermediate capacity.

In localized illumination the lamp, usually a carbon filament incandescent lamp or other small unit, is hung over the machine or bench, and is usually under the control of the workman. The area illuminated is relatively small, and the intensity falls off rapidly from the point of maximum illumination. It is particularly adapted to certain conditions of manufacture. For example, illumination of deep borings, molds, interiors of cupolas, or other places where a general illumination could not well penetrate; illumination of straightening or inspecting processes, where the image or reflection of the light is specially employed, and in very fine work requiring an intense illumination over a small area. When not used to the best advantage, however, the localized lamp is apt to produce eye-strains, and when used without reflectors is not only wasteful of light, but makes it almost impossible to avoid glare.

Such lamps are often exposed to considerable breakage, and although low-priced lamps are used, the renewal cost is high. This, combined with the wear and tear on the extension cords, sometimes results in excessive maintenance expense, especially as the small unit makes necessary a large number of outlets.

With general illumination, an attempt is made to provide an approximately even intensity of illumination throughout a workroom. This ideal is never quite realized, except possibly when the lamps are hung at a considerable height. Lamps are usually spaced equally throughout a room, the most efficient illuminants are available, and since there are fewer outlets required, the initial wiring cost and maintenance expenses are likely to be relatively low. General illumination is best adapted to large high shops, especially where crane ways require the location of the lighting units along the sides of the room or above the cranes. General illumination is especially desirable, on account of safety, where large powerful moving machinery is used, as in rolling mills, erecting bays, iron foundries, and similar places.

Combined general and localized illumination is used in shops where a low or moderate intensity will answer most requirements, but where a higher illumination is required either at a few localized points, or only occasionally. For example, a group of automatic

screw machines requires but a moderate general illumination when in operation, but when the workman has occasion to set up or adjust one of these machines, a more intense illumination is required at that particular point. Since a workman ordinarily attends to a number of these machines, it is good practice to provide him with a lamp and short extension which can be connected or plugged in at convenient points near the machines.

Mr. Stickney applied the term localized-general illumination to the practice of producing general illumination by means of units arranged regularly, but with reference to the machinery or processes to be lighted, so as to provide a higher intensity of illumination at important points than elsewhere. The units are located also with regard to giving suitable direction to the strongest light on a certain machine, thus avoiding objectionable shadows and reflections. The size of the units is selected to suit the spacing and amount of light necessary.

This practice has been brought about by the tungsten lamp which made available a series of efficient units throughout a large range of capacities. This type of illumination is now being used to a very large extent for looms, lathes and other machinery where the size and spacing of the machines is such as to permit fairly uniform spacing of lamps. It may be said to bridge the gap between localized and general illumination, and is made particularly effective by the ability to select units of any desired capacity and equip them with reflectors which concentrate or spread the light over wide or narrow angles.

H. O. STEWART [1] wrote a discussion of the question of how to determine the sum of money that might justifiably be expended on illumination. A daily departmental record of the output, the number of employees and of machines operated, should be kept, as well as a daily record of the local weather conditions and the time each day that the lights are turned on. With these data, the average hourly output per employee of each of the several departments, both during bright days when no artificial light is required and during cloudy days when it is, can be determined.

Assuming that it would be possible to increase the output during dark weather nearly up to that under the best conditions by means of first-class illumination, the maximum yearly amount to be spent for illumination can be roughly determined. In general it will be

[1] Rochester Ry. & Light Co., Rochester, N. Y.

found that an investment of at least a part of that amount will be an exceedingly profitable one.

Ideal factory illumination consists of sufficient light for each workman to perform his duties accurately and with maximum speed, and minimum glare both from direct light sources and polished surfaces, and freedom from objectionable shadows. The last can be reduced in magnitude either by increasing the number of light sources, or by better diffusion of light which may be accomplished by painting the ceiling with white oil paint and the walls with oil-paint of light color, and using prismatic or similar glass reflectors.

For foundry lighting, on account of the smoke and vapor in the air, a source of light with predominant red rays should be used, such as a flaming arc. The best type of lighting for a drafting room is the indirect system, with lamps contained in trough or bowl reflectors suspended a short distance below the ceiling. The light first strikes the ceiling and walls and is then reflected upon the drawing boards. The best results are obtained from flat ceilings and walls painted with white oil paint.

LUTHER D. BURLINGAME discussed the plan by which parts of a machine are manufactured as separate units, complete in themselves, the department where such units are built being to a large extent equipped with the different kinds of machines needed to perform the various operations required in their manufacture. This may be named the group department plan.

In taking up this discussion the questions may be raised, under what conditions is it of advantage to build parts of machines as distinct units, and how shall the machinery in the shop be grouped to manufacture them most economically.

Taking up the first question, some of the reasons for dividing a machine into separate units to aid in manufacture are: (*a*) where the nature of the unit is such that it can be manufactured to better advantage in a particular department equipped for that class of work; (*b*) where it is used for more than one machine and can be manufactured for stock in larger quantities than any of the machines on which it is used; (*c*) where there is a constant call for such part to be used either for repairs or on special machines; and (*d*) where the work is of such a nature that a sufficient saving can be effected to warrant manufacturing in larger quantities than in the case of the machine itself.

The system of manufacturing parts of machines as independent units has been in use by the Brown & Sharpe Manufacturing Com-

pany for many years, having been the subject of patents owned by that company but which have now expired. This principle of manufacture is applied to almost all lines of machines made by them. In investigating the systems in use by some progressive shops abroad recently Mr. Burlingame found it to be the almost universal practice to use some system of unit stock parts.

As an illustration of the kind of grouping referred to the spiral head of a milling machine might be mentioned. This forms a self-contained unit which can be manufactured to advantage in a separate department under this plan, a unit for the manufacture of which the foreman can be held responsible as to cost, time of completion, accuracy, and finish. The cost of such a unit can be known more exactly by this method than in the case where it is not separated from the complete machine, for by building it as a separate unit it is possible to know more exactly just where there is a gain in manufacturing and where there is a falling behind.

By the system here advocated all stages of the work for a complete unit of manufacture can be under the eye of a responsible man who can put all his experience and enthusiasm into reducing the cost, raising the standard of workmanship, and seeing that the work is completed at the time needed. This method of manufacture also gives a great degree of flexibility allowing for readily transferring the work or any part of it from one department to another.

A shop manufacturing a great variety of tools or machines and organized on this system may not only have all the advantages of one confined to a single product, including thorough attention to details and concentration on perfecting a given line of manufacture, but in addition there are special advantages making it possible to do work better and more economically by having men trained as specialists for each particular line of work, and it is also possible to have expensive special machines and equipment, the cost of which can only be warranted in a large shop.

The question of how the machines shall be arranged is not necessarily dependent on the size of the shop. The large shop may be arranged so as to be like a number of small shops but under one management.

When an important order is to be rushed through this method of manufacture has advantages over a method where each operation is performed in a different department, for the whole job in the former case can be under the eye and control of one foreman. Also by knowing all the ins and outs of the manufacture, intelligent sugges-

tions for improvement and improved methods of manufacture are more likely to be made.

This brings us to the second consideration, as to how far a department should be organized to do all the necessary work itself on a given unit of manufacture, and how far parts of the work should be routed through special departments equipped for a particular kind of work. Some of these lines of division are well settled and we can pass them by and come to those where there is a difference of opinion and practice. For instance, it is hardly necessary to discuss the question as to whether there should be one foundry, forge shop, hardening room, smith shop, etc., to serve the whole shop, and it is almost universal practice to have all work for the departments of general grinding, gear cutting, screw making and polishing sent to the one department rather than to scatter the machines for such work throughout the works.

The more specialized the operations are the greater the reason thus to have the machines of a given kind together in a department to serve the whole shop. An argument in favor of such an arrangement is that it will require fewer machines to take care of a given product because there will be times of rush and times of idleness which can better be equalized if all the machines of a kind are together. This separating of machines of a given class into departments also makes it possible to put work in a size and kind of machine just suited to it, which is not always possible when these machines are scattered about the works. It might be contended that this same reasoning should extend to the locating of lathes, milling machines, drill presses, etc., as recommended under the output department plan. Experience has taught, however, that a combination of these different methods of dealing with shop work is often of advantage and that it becomes a question of deciding in each particular case where to draw the line to obtain the best results, everything considered.

In a line of manufacture such as the spiral heads, even though much of the work may be said to be carried on on the one-shop plan, many of the operations are performed in other departments than that in which the spiral heads as a whole are built and many of the parts are completely made in other departments. For example all the screws, studs, and some small parts are made in the screw machine department and carried in stock. The gears while being turned in the department where the spiral heads are made have their teeth cut in the gear cutting department. The index plates are

drilled in a special department equipped for precision work of this character, the graduating also being done in this same department. The grinding is all done in the general grinding department. The various parts, however, are made and the operations performed on order from the foreman having charge of the manufacture of spiral heads, and he is held responsible for the completed work.

The decision as to which method to adopt depends wholly on an examination of each particular case and its requirements, and upon what combination of these methods can be used to produce the required results most economically.

H. M. LAMBOURN,[1] speaking upon the subject of shop floors, said that a selection of the materials best suited to a given structure could be made only after an investigation of the destructive agents to which all building materials are susceptible. No one material is best adapted to all cases.

The most active destructive agents commonly at work are attrition, due to use and vibration, fire, water, chemical reactions, and vegetable fungi.

In applying these elements of failure to factory floors, the supporting members of the structure are to be considered as an integral part of the flooring system, since the failure of the supporting members to fulfil their purpose of design would condemn an otherwise satisfactory structure.

The three systems of supports in common use in factory design are timber, steel and reinforced concrete, cost or fitness governing the application of each. Both timber and reinforced concrete have good resistance to destruction by fire in mill construction, and while the latter must take precedence, there is much to favor the former. Steel supporting work has failed so frequently in cases of fire that insurance engineering of the best character recommends its use in hazardous locations only when fireproofed.

Steel framework will transmit vibration much more readily than either timber or reinforced concrete, and is therefore not well suited for structures subject to shock from unbalanced machines or pure shock operations.

In the presence of moisture, reinforced concrete is the best material, with timber second, and unprotected steel the least desirable.

Active chemical fumes are best withstood by timber in the majority of structures, with reinforced concrete and steel about equally

[1] Supt., Power and Plant, Yale & Towne Mfg. Co., Stamford, Conn.

valuable. Acid-resisting coatings are not always effective, and the design in such cases should provide for easy replacement of structural members liable to attack.

Fungi and dry rot are to be considered only in the case of timber, and when there is a good circulation of fresh air little is to be feared from these causes.

In regard to the supporting floor proper, practically but two materials are in use, timber and reinforced concrete, upon which the additional floor coverings are laid if any are required. Two methods of design are in use in the timber supporting floors, in one of which planks of a width greater than the depth are either rabbeted on both edges and a suitable spline inserted, or also tongued and grooved; and a second in which square-edged planks of a depth equal to or greater than the width are spiked together. Of these two, the latter has several advantages, because of its stiffness against both deflection and vibration, due to the mass being intimately tied together, and also to the fact that the floor level and consequently the machine levels are unaffected by the warping of the plank, as in wide faced and heart timber. Moreover, it is little if any more expensive to lay than a close-fitting splined or tongued and grooved flooring. Reinforced concrete as a base or foundation flooring material has many advantages, the most important being its fire-resisting qualities. In the case of factories using much machinery, its freedom from vibration under usual conditions adds largely to the life of machinery and reduces the cost of replacements and repairs.

The difference in weight of concrete and wood, about 140 lb. against a probable average of 50 lb. per cu. ft., adds about three times the mass for equal thickness of floors, and consequently an increased inertia for equal vibrations. Reinforced concrete supporting floors for equal spans and strength are thicker than wooden floors, and consequently the mass is still more increased.

The question of freedom from vibration, other things being equal, in manufactories where duplication of parts is required, becomes a highly important factor in the cost of production. But quite equal in importance with stiffness against vibration is stiffness against deflection for the support of machinery whose proper functioning requires it to be level or within a given plane.

The elements of designing against deflection to prevent cracking of plaster are well understood, but in factory flooring deflection is seldom considered, or the assumed live load is supposed to cover the case, but with modern speeds, increased machine weights and dupli-

cate manufacture, deflection in each case is worthy of fuller investigation.

Where a top or wearing floor covering is used, it is usual to add an intermediate flooring of thickness varying with the material of the supporting floor. In the case of a timber base, the intermediate floor is usually of boards, at right angles to the direction of the supporting plank, and so adds to the stiffness. With a reinforced-concrete base and a wooden wearing floor, the intermediate flooring of boards or plank is laid on screeds which have been bedded in tar concrete, or in cinder concrete, the purpose of this intermediate flooring being to make a ready fastening for machinery or a base for close nailing of the top flooring. Where waterproofing is applied, it should be placed under the intermediate flooring. All screeds should be chemically treated or else coated and laid in a bituminous envelope to preserve them against dry rot.

In factory floors the wearing surfaces are of wood, concrete, iron, brick, asphalt or clay.

The woods usually employed are Southern pine, either common sawn, rift or comb-dressed, maple, beech, birch, oak, hemlock, and spruce. Of these materials the most common are Southern pine and maple. Maple of a factory grade is being extensively used and has gained favor due to its wearing much more evenly and smoothly, its good resistance to wear and its favorable price. Beech and birch are not used generally, but frequently come mixed in small quantities with maple. The oldest flooring surface in modern factories is Southern pine, common cut. This material has usually worn well when the trees from which it was sawn have not been tapped to death and there was the required density to season well. The common cut has the disadvantage of breaking up in splinters when worn and so being dangerous. The rift cut or comb-dressed Southern pine overcomes the objection of splintering and has great wearing qualities. Its cost is somewhat greater than maple of the factory grade. Oak has been used and at the present time a factory grade is being produced which probably has greater resistance to wear though costing more than other wooden floor coverings. Hemlock and spruce are used only in the cheaper grades and are at best but poor substitutes for the harder and closer grained woods.

The face of the finishing flooring should not exceed 3 to 4 in., and should be planed with a hollow back and square edge, with or without a tongue and groove on the ends.

The square edge facilitates repairs, gives greatest floor covering

surface for the board feet of flooring purchased, and is less expensive to lay. Face nailing should be used except in special cases, since blind nailing interferes with ready repairs.

Since the wear of floor surfaces comes mostly from travel and trucking, the floor boards should be laid in the direction of maximum travel, since a cross travel wears the boards much more quickly and unevenly. Uneven wearing is very detrimental to low production costs, where the finished product is of a perishable nature and cannot be subjected to rough handling. On the other hand, wooden wearing surfaces are perhaps the best from the standpoint of health, causing the least abstraction of bodily heat.

All wooden top flooring should be laid up with floor jacks, since there is not only a decided gain in the quality of the laid surface, but the same can be put down more quickly, and with less likelihood of nails splitting the boards. The nails should be cut; best of all, tempered steel cut nails, all well set after driving.

In the presence of much heat, large quantities of moisture and chemicals in bulk, wooden floor coverings should not be used.

There seem to be many valid objections to concrete floor coverings in the majority of cases. When first laid and well troweled, concrete makes a very attractive flooring, but as soon as use and wear begin becomes difficult of upkeep and repair. The wearing away of the first troweled surface is the beginning of much more rapid wear, and with a crack or joint once started there is soon developed a bad hole under shop trucking and handling of heavy materials.

Unquestionably, there is a much more rapid abstraction of bodily heat through the feet on a concrete floor surface with its attendant feeling of bodily discomfort. Where the character of the work produced is of a small or intricate nature and nervous rather than phlegmatic dispositions are required for rapid and economical manufacture, these conscious feelings of discomfort greatly decrease production.

In the presence of intense heat and free acids, a concrete surface is soon destroyed and because of the difficulty of repair becomes a burden of expense. By intense heat is meant such a condition as would arise where hot metal is spilled. The disintegration is here due to the probable presence of moisture and the kicking off of small particles from the sudden formation of steam. In places where there is not much wear, as in certain classes of store rooms, and where there is a liability of much moisture, as in wash rooms, concrete floor

coverings are most acceptable. As a foundation material concrete in its several forms will probably be the most universally used material of building construction, but as a finishing material there is much yet to be developed in its methods of handling and treatment to place it in the front rank.

Cast-iron plates are excellent coverings for the runways of foundry floors and in places where hot metals are liable to be spilled, but in their use, care should be taken to place them where the character of wear will not cause them to become smooth.

Brick affords a good covering for floors where there is heavy trucking, much moisture, intense heat, or scouring wear, and in the foundry is finding more and more favor, one of its great advantages being its easy and unit replacement.

Asphalt coverings are susceptible of wide application in factory flooring, principally because of their water and acid resisting qualities, and partly because of their flexibility of installation when applied by trained workmen. They are also good fire retardants and are largely used where the nature of the material is inflammable.

The asphalt floors are found in plating rooms, toilet rooms, acid dip rooms, die houses, bleacheries, laquer rooms and similar locations. When applied over wooden floors they are first underlayed with a covering of building paper and the hot mastic properly tempered, poured on top. There have been some criticisms against asphalt coatings wrinkling after being laid, but this difficulty can be overcome by properly tempering the mixture of mastic and sand.

There have been brought out several composition floor coverings, and undoubtedly the most extensive comparative study of actual wearing qualities is now being conducted by the New York Central Railroad, at its Grand Central Depot. The records of these tests would make a most important addition to our knowledge of this class of floor coverings. There has been a recent replacement, in part, of one of these composition coverings at the New York Hippodrome, where slate treads were inserted in the place of composition treads on the stairs.

F. A. Waldron (written). The selection of design of a factory floor depends on the character of the product. Concrete, brick, wood, clay, asphalt, granolithic, mosaic, tile, terrazo, and patented compositions are all used successfully and economically. In factory development and construction as applied to light manufacturing, the concrete floor of equal parts of cement and sand is undoubtedly cheaper in first cost; its wearing qualities and means of repairing are,

however, questionable. In a number of cases the dust from concrete floors has been found objectionable and it has been necessary to use a paint to prevent it. Also where operators are required to stand in one position all day it is not satisfactory and wood platforms are necessary.

In the writer's judgment wood top floor of beech, birch or maple, laid on tar concrete having nailing strips bedded about 16 in. apart, coating the wood with a good composition floor dressing, makes the best machine shop floor for buildings of this character. The first cost is about double the concrete and about the same as patented composition. It is more comfortable, can be repaired, is free from dust, and will allow more flexibility and more rapidity in relocation of machinery.

A much better piece of flooring is obtained by laying $1\frac{1}{4}$ in. N. C. sheathing diagonally on top of the tar concrete and then on top of this sheathing a $\frac{7}{8}$ in. beech, birch or maple flooring with two thicknesses of resin-sized paper between this top floor and the sheathing. This adds about 6 cents per sq. ft. to the cost.

These floors should never be laid on cinder concrete for shop use, as there is not the support between nailing strips and as the cinder concrete is laid below the line a dead air space is formed and the element of stiffness is also lacking. More complete combustion takes place in case of fire. Inflammable dust also sifts through cracks and accumulates in these spaces.

The surprising feature of the construction of the buildings described in the paper is the use of floor beams, when a flat slab would be much better in many ways, especially for light, belting, countershafts, electric wiring and sprinklers, water and steam piping.

In the choice of materials for top flooring, the following order should be observed: maple, beech, birch, edge grain yellow pine, although the last named wood will not last as long on floors where there is trucking as it will on stairways. Experiments have shown that edge grain yellow pine stair treads will outlast two maple, birch or beech treads.

Henry K. Rowell (written). The chief reason for using reinforced-concrete construction in place of the slow-burning mill construction for textile mills seems to be the growing scarcity of timber. The expense of reinforced construction is about 25 per cent more. For a modern slow-burning type of mill for the textile industry the insurance rates will be assessed from one-half to three-quarters of one per cent on the insurable value, and the premium rates will be

further reduced by dividends. So small have been the losses of buildings from fire in the textile industry in this type of construction that it is almost a negligible amount. As an offset to any saving in the insurance due to reinforced concrete, there would be the increased assessment of taxes, as it seems reasonable to assume that a higher assessment would be made on the more valuable building. The writer does not know of any case where such a comparison could actually be made. It remains a question of fact as to which would be considered of the higher market value, the slow-burning or reinforced-concrete types of construction.

In the matter of the depreciation of a plant, the rate would probably be about equal as between the two types. The physical life of the reinforced-concrete buildings would be assumed as greater probably, but, except in the case of dye houses, this is open to question, as worn bearings due to cement dust, extra repairs required for looms owing to a too rigid floor, and the cracking of walls, floors and beams, etc., would appear to indicate. Buildings depreciate not only because of wear but also of adaptability to use, due to advancement in the mechanical arts.

With reference to the hardness of concrete floors, while people soon become accustomed to their environment and cease to complain, any one, and particularly a woman or child, subject to the unyielding quality of stone, brick or concrete, must fatigue more rapidly than those subject to the more elastic quality of wood.

The difficulty in patching worn places in the floors seems to be one of the serious difficulties with a granolithic floor. The matter of drilling holes through the floor for holding down bolts seems objectionable, also. Where holes are drilled through the ceiling of a card room, when the floor above is washed every hole affords a channel for water to run down and drop on to the cards and subject the mill to a loss of perhaps hundreds of dollars worth of card clothing.

The board overlay would seem to be more satisfactory since it offers an easier medium to stand upon and because machinery can be screwed to the floor easily without destroying the concrete. The floors can be made waterproof and the boards easily replaced when they become worn.

In the experience of the writer, a reinforced-concrete floor with granolithic finished surface was built in an engine room. The engine was installed and after running a short time it was noticed that the bearings were becoming cut with grit and wearing badly. The floor was then entirely covered with linoleum glued down hard, and there

was no more appreciable wearing in the bearings. The linoleum was easily kept clean and proved very satisfactory.

In the matter of insurance for a textile mill, the writer had occasion to take this matter up with an insurance company who assured him that the rates were practically the same for both reinforced-concrete and slow-burning types. The chief advantage of the reinforced-concrete building is that a fire can be more easily confined to one room, but owing to the light inflammable material in the machines a fire once started will sweep through the room very rapidly and will flash over the floor if it is oily. The risk is not much greater, therefore, in either case. Fortunately the machinery builders are using steel now where they once used wood.

FOREIGN REVIEW

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

An Index to Current Articles in Foreign Periodicals, with Abstracts of Some of the More Important

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TOPICAL INDEX OF CURRENT ARTICLES[1]

Aeronautics

(See also Internal Combustion Engines, and Strength of Materials).

ZUGKRAFTDIAGRAMME VON FLUGZEUGEN, Georg König. *Zeits. für Flugtechnik und Motorluftschiffahrt*, December 30, 1911. 4 pp., 9 figs. *h*. Theoretical investigation of principles underlying the determination of *necessary and available tractive power for airships*.

LUFTWIDERSTANDSVERSUCHE MIT GRÖSZEREN AEROPLANFLÄCHEN, A. von Parseval. *Zeits. des Vereines deutscher Ingenieure*, December 30, 1911. 3 pp., 21 figs. *d*. Describes tests on *resistance of air* with respect to large aeroplane surfaces made by the author and Colonel von Siegsfeld in 1890 and 1891.

UNE QUESTION D'ÉQUILIBRE, C. F. *La Technique automobile et aérienne*, January 15, 1912. 2½ pp., 2 figs. *c*. The author, following a former investigation by Mr. Esnault-Pelterie, proves mathematically that a motor with a fan-like arrangement of cylinders cannot be as perfectly balanced as a motor with a star-like arrangement. He compares the two types, with special regard to their application in aeronautics. The fan-like motor admits of a perfect lubrication, which is very difficult to get at in a star-like motor, but cannot be as perfectly balanced, and is apt to produce undesirable vibrations in the machine. This did not matter much as long as aerial motors were small, but when Mr. Esnault-Pelterie started to manufacture a 90-h.p. motor he was perfectly justified in replacing his former fan-like arrangement by a star-like one.

Cranes

FLYTEKRAN DREVET AV PETROLEUMSMOTOR. *Teknisk Ukeblad*, January 19, 1912. 1 p., 1 fig. *b*. Describes a floating crane equipped with an oil motor built for the Dry Dock Company of Rotterdam, Holland.

VERSUCHE ÜBER DIE SPANNUNGSVERTEILUNG IN KRANHAKEN, E. Preusz. *Zeits. des Vereines deutscher Ingenieure*, December 30, 1911. 4 pp., 18 figs. *c*. Description and data of tests on the distribution of strain in crane hooks.

Fuel

DIE SELBSTENTZÜNDUNG DER KOHLE, Schorrig. *Zeits. für Dampfkessel und Maschinenbetrieb*, January 5, 1912. 2½ pp. *h*. Exposition of several theories, mainly German, on the causes of spontaneous combustion of coal and lignite briquettes.

[1] Opinions expressed are those of the reviewer, not of the Society. Articles are classified as *a* comparative; *b* descriptive; *c* experimental; *d* historical; *e* mathematical; *f* practical; *g* general; *h* theoretical. Articles of exceptional merit are rated *A* by the reviewer.

AUSNUTZUNG MINDERWERTIGER BRENNSTOFFE AUF ZECHEN DES OBERBERGAMTSBEZIRKS DORTMUND. Bütow and Dobbelstein. *Glückauf*, January 6, 1912. 14 pp., 28 curves. *c*. Data of an investigation to determine the economic possibilities of the use of *cheap grades of fuels*.

DIE VERWERTUNG VON NATURGASEN DURCH VERBRENNUNG UNTER DAMPF- UND DESTILLIERKESSELN. Karl Feldmann. *Petroleum*, December 20, 1911. 3 pp., 8 figs. *f*. Discusses various methods of *utilizing natural gas*, and describes various systems of burners, among others those used in Galizia and Caucasus.

ØKONOMISK OPVARMNING AV VORE BOLIGER. Kjeld Helgeby. *Teknisk Ukeblad*, January 5, 1912. 3½ pp. *a*. Compares various systems of heating from the economic standpoint. Under Norwegian conditions (in particular for Trondheim) electricity appears to be the most expensive fuel 2.70 öre per 1000 calories of useful heat, or $0.015 per 1000 B.t.u., at a price of 80 öre ($0.18) per kw-hr., while peat is the cheapest—0.96 öre per 1000 calories of useful heat, or $0.006 per 1000 B.t.u.

SUL COMPORTAMENTO DEI CARBONI DA GAS NELLA DISTILLAZIONE IN GRANDE MASSA. D. Menenghini. *L'Industria*, January 17, 1912. 2½ pp., 1 fig. *f*. The author finds Campredon's method of measuring the caking capacity of bituminous coal[1] inadequate in the case of gas coal: (*a*) because sand 17 to 20 times the weight of coal would have to be added, and that would make it very difficult to obtain a uniform mixture of the coal and sand; (*b*) because the basic materials in the coal may produce a cementation of the silicate in addition to what is done by its bituminous constituents. Dr. Menenghini offers, therefore, the following method, which gives both the caking capacity of the coal, and its increase in volume at gasification. He found that there is for each type of bituminous coal a nearly constant relation between the amount of volatile substances contained in the coal and the amount of clean fine sand which the coal can take in (cake in) at gasification. The method consists in placing a gram of finely powdered coal in a platinum crucible, and pouring over it in a fine stream, so as to completely cover the coal, two grams of fine clean silicon sand; the amount of coke is determined by the American method.

Hydraulics

VATTENTURBINERNA FÖR STATENS KRAFTVERK VID TROLLHÄTTAN. K. Dahlgren. *Teknisk Tidsskrift-Mekanik*, January, 1912. 7 pp., 17 figs. *b*. Describes the water turbines at the Trollhättan hydroelectric plant.

BEITRAG ZUR NACHRECHNUNG UND AUSLEGUNG VON BREMSVERSUCHEN AN WASSERTURBINEN NACH DEM DIAGRAMM VON PROF. DR. CAMERER. Otto Böhm. *Zeits. für das gesamte Turbinenwesen*, January 10, 1912. 4 pp., 12 figs. *h*. The first of a series of articles on the calculation, using Professor Camerer's diagrams, of the *actual power delivered by the water, and the losses in, the turbine*, from the mean values indicated by the brake test.

[1] Guide du chimiste métallurgiste et de l'essayeur, Campredon. A certain amount of coal is caked in a vessel, and fine sand added, as long as the coal is able to take it in and form a solid block. The amount of sand taken in shows the caking capacity of the coal.

Internal Combustion Engines

VERGASER AUF DER AUTOMOBILAUSSTELLUNG 1911, A. Berger. *Der Motorwagen*, December 31, 1911. 4 pp., 7 figs. *b.* Describes various systems of *carburetors:* Zenith, Marvel, Solex, Sperber, Brennabor, Favorite, and Fiat.

MODERNE GASERZEUGER IM GLASHÜTTENBETRIEB, K. Quasebart. *Sprechsaal*, January 4, 1912. 1½ pp., 3 figs. *b.* Description of *gas producers used in the glass industry.* Only high-grade fuels can be used for smelting glass.

NYE KRAFTMASKINER I 1911, C. F. Helmboe. *Elektroteknisk Tidsskrift*, January, 1912. 2 pp., 3 figs. *b.* Description of the Holzwarth gas turbine and Tesla steam turbine. The part referring to the Holzwarth gas turbine is a translation from Mr. Holzwarth's book on that subject, and can be found in English in Power, February 6, 1912.

SEEFISCHEREI-MOTOREN, F. Romberg. *Dinglers Polytechnisches Journal*, January 6, 1912. 6 pp., 40 figs. *bf.* Analysis of conditions which a *motor for fishing crafts* must satisfy, and description of some of the German types.

NEUERE ROHÖLMOTOREN, Ch. Pöhlmann. *Dinglers Polytechnishes Journal*, January 27, 1912. 2½ pp., 2 sheets of drawings. *b.* There seem to be advantages in providing large *Diesel engines with crossheads.* If the cylinders have to take care of the pressure on the guide face they must be correspondingly large and strong, and therefore expensive; the wear and tear of the liners and cylinders is also quite appreciable, and, since as a rule the piston is not adjustable, there develops a jerky, noisy working and poor volumetric efficiency. A further disadvantage of engines without crossheads consists in the fact that the piston-pin is inside the hot piston, and that makes the cooling more difficult. The lubricating materials become, owing to the high temperature, very fluid, and give poorer lubrication. Therefore high pressures on piston pins cannot be used, and 120 kg/qcm (about 1600 lb. per sq. in.) is probably the maximum allowable, while for crosshead pins which move in open air, pressures as high as 150 kg/qcm (say 2000 lb. per sq. in.) and even higher may be safely used.

The only firm in Europe which builds crosshead Diesel engines is the Grazer Waggon- und Maschinenfabrik-A.-G. Their engine is of the four-cylinder four-cycle type, 600 mm. (23.6 in.) bore, and 800 mm. (31.4 in.) stroke, with the cylinders in two twin groups, and gives 800 effective h.p. at 160 r. p. m. The bed-plate, 7.73 m. (25.3 ft.) long, is cast in two pieces and bolted together in the middle. The crank-bearing is long and as a result the maximum specific pressure at the bearings is very small, and at starting amounts per sq. cm. of the pin surface to only 30.5 kg. (433 lb. per sq. in.), and when running 26 kg. (370 lb. per sq. in.).

The hollow crankshaft is in two parts, with flanges, joined at the middle, and is cooled by water entering axially at the left end.

The forked connecting rod is made hollow and carries at its upper end the crosshead beam of the one slipper crosshead. Since the latter moves in free air the pressures on it are allowed to be as high as 130 kg/qcm (1740 lb. per sq. in.) when running and 150 kg/qcm (2000 lb. per sq. in.)

at starting. The crosshead guide face, which has to withstand a pressure of more than 11 tons during expansion, has a cylindrical guide. The slipper of the crosshead which takes up the comparatively small pressure of the compression stroke is provided with adjustable flat guide plates. The piston lubrication is rather peculiar. The cylinder bush has a number of holes bored through it parallel to the axis and ending at a certain height in a common ring-shaped oil groove. The oil enters these holes under pressure and, on coming out from the cylinder bush, is collected in a ring-shaped trough at the lower end of the cylinder liner. The piston has at its lower end a cylindrical iron wiper which dips into the oil trough when the piston reaches the lower dead centre, and carries it up with a few drops of oil, thus preventing waste and danger.

DIE DAMPFZERSETZUNGSFÄHIGKEIT DER GASERZEUGER, Hudler. *Glückauf*, December 30, 1911. 3 pp. *h*. An attempt to answer the question, *How much steam per unit of weight of combustible must be brought to the producer grate in order to convert the largest amount of available heat into chemical energy*. The author operates with the data obtained by Bone, Wheeler and Allcut from experiments with a Mond producer of 3 m. (9.84 ft.) in diameter, and a power-gas producer ¼ m. (say 10 in.) in diameter. The efficiency of the Mond producer per heat unit was always higher than that of the small producer, but in the Mond producer the content of CO_2 rapidly increased with the increase of content of hydrogen, while in the small producer it changed very little. The author calculates heat balances for both producers, and comes to the conclusion that CO_2 in the small producer is made up of oxygen from the air, and in the Mond producer from the decomposition of steam, and that this is the reason why the content of hydrogen increases simultaneously with it. He shows further that the efficiency of a Dowson gas producer, expressed in chemical energy, is directly proportional to its dimensions, provided the load per unit of cross-section is the same.

L'INFLUENCE DE L'ALTITUDE SUR LA CARBURATION, A. Lauret. *La Technique automobile et aérienne*. January 15, 1912. 2 pp. *h*. The author attempts to explain why *carburetors* give trouble in automobiles at some 3000 to 4500 ft. *above sea level*, and gave no trouble to Garros when he went up about 14,000 ft. with a Zenith carburetor. As the elevation increases the density of air decreases, the amount of air drawn into the carburetor decreases also, and that results in a proportional decrease of the amount of explosive mixture. On the other hand the absolute compression pressure decreases also, but then the back-pressure of exhaust is smaller, and the last gives to the motor an important advantage. That the mixture becomes richer as the compression decreases is comparatively slightly known.

As regards the influence of high elevation on the speed of rotation of a motor, the author shows that as the density of air decreases the head resistance decreases also, but so does the raising force of the air, the last making it necessary either to increase the angle of incidence of the wings, or to increase the speed of translation which is made difficult by the de-

crease of resistance which the air offers to the propeller. All this makes the problem of conditions of flight at high altitudes somewhat complicated.

The author proceeds to show mathematically that the action of a carburetor of the Krebs type (compressed air type) depends entirely on the density of the air drawn in, and when that changes it is not enough to reduce the jet spray nozzle, but the tension of the spring of the supplementary air valve must be changed. At high altitudes the carburetor does not remain automatic, but delivers more fuel than is necessary, which is especially inconvenient, as there is already a tendency toward the mixture becoming too rich. In a carburetor on the regulation of supply of fuel principle, such as the Zenith, the action depends on the amount of fuel delivered, and is independent of the density of the air, thus making possible an automatic regulation of carburation even at high altitudes.

Die Internationale Ausstellung von Verbrennungsmotoren in St. Petersburg 1910, N. Bikoff and G. von Doepp. *Die Gasmotorentechnik*, January, 1912. 7 pp., 10 figs. *b*. Describes engines at the International Exhibition of Internal Combustion Engines in St. Petersburg in 1910, including Swedish types of the Motala and Bolinder Companies in Stockholm. The Bolinder motor has a peculiar construction of the cylinder cover and explosion chamber, which is connected with the inside of the cylinder by two inclined ducts, through one of which the atomised fuel is led to the explosion chamber from the atomiser, the usual screw in the atomiser not being used in this motor. The timing of ignition is done by the water injected into the cylinder, the water coming through a little boiler from the cooling jacket to the cylinder, and the amount of it being regulated by hand according to the load.

Kraftgasgeneratorlage für Feinkohle, H. L. *Braunkohle*, January 12, 1912. 2½ pp., 1 fig. *b*. Description of the Petzold *step-grate gas producer* for slack coal. The inventor gets rid of the usual trouble with slack coal gas producers (high percentage of carbon dioxide in the gas) by building an inclined wall against the bottom of the step-grate. This wall does not permit the gases to pass directly to the gas holder, but forces them through the glowing fuel, thereby considerably reducing the contents of CO_2. For a complete reduction of the carbon dioxide it is necessary, however, that the fuel be packed close to the wall, and that there be no holes between it and the wall.

Note au sujet de l'équilibrage des moteurs à combustion interne à allure rapide, Hutter. *Mémorial du Génie Maritime*, December, 1911. 32 pp., 15 figs. *h*. Investigation in the theory of balancing of high-speed internal-combustion motors. The author investigates the influence of angular accelerations, and shows that even slight irregularities, if they are sudden, may give rise to considerable inertia forces. A new condition for balancing the forces of inertia is, therefore, introduced: the cylinders must be adjusted in such a way as to insure the greatest possible regularity of the motor couple. Proper balancing of an engine affects its efficiency. Even slight vibrations if rapid, when transmitted to the engine body, represent a serious loss of power, and may even lead to a breakdown.

LES MOTEURS SANS SOUPAPES À QUATRE TEMPS, G. Lavergne. *Revue générale des sciences*, January 15, 1912. 8 pp., 12 figs. *b*. Describes various *four-cycle motors without poppet valves*. Besides the Knight motor, the following are described and illustrated: The *Rolland-Pilain motor* (Fig. 2) has a cylindrical shell with liner placed between the piston and the cylinder and supporting a long segment *S* provided with admission and exhaust openings *A* and *E*. These openings are on the same level, while the admission and exhaust ports in the cylinder are on different levels. The liner is given such a motion that the segment *S* closes perfectly tight the admission and exhaust ports during the periods of compres-

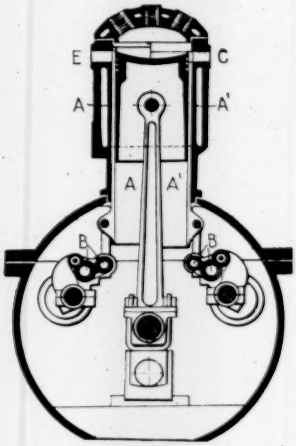

FIG. 1 MUSTAD MOTOR

sion and explosion. This could not be done by a connecting rod and eccentric, and the following arrangement is made use of: two eccentrics are used, one on the crankshaft, and the other on a half-speed shaft driven by an endless chain from the crankshaft. Two points on these eccentrics are joined by connecting rods with the ends of a beam, in its turn connected with the liner of the cylinder. Admission and exhaust can be advanced or retarded by changing the length of the pieces in this gear. There is considerable play between the liner and the cylinder, and only the segment has a tight fit. It seems therefore that seizing of the valve gear is less likely here than in the Knight motor. The *Mustad motor* (Fig. 1) has also a liner, but it is divided into two parts *A* and *A'*, of which the first takes care of the exhaust port *E*, and the other of the admission port *C*. They are actuated by connecting rods *B* and *B'* driven by eccentrics from two shafts rotating at half the speed of the crankshaft, and connected with it by a gear not shown in the drawing. The manufacturers claim that a four-cylinder motor, with a bore of 90 mm. (3.54 in.) and stroke 110 mm. (4.32 in.), delivers 28.5 h.p. at 1500 r.p.m., with a consumption of only 221 grams (0.486 lb.) of oil per h.p-hr., with a maximum output of 33 h.p. The *Miesse motor* (Fig. 3) has also a cylindrical liner *A* actuated by a mechanism *B* driven from a half-speed shaft, but the liner opens and closes a single orifice *D* which serves both for the

admission and exhaust. To do that, a cylindrical slide valve *H* consisting of two interconnected pistons and actuated, like the liner, by the mechanism *B*, brings against the orifice first the admission, and then the exhaust port. This arrangement has the advantage of cooling, by the passage of fresh gases, the orifice heated by the exhaust. The *Berliet motor* has the cylindrical slide valve of the Miesse motor, but no liner. The author proceeds to describe the motors of Henriot, Cottereau, and Broc which have been already described in The Automobile (August 3, 1911), and the motors of Boissier and Ballot, which are modifications of the Henriot type.

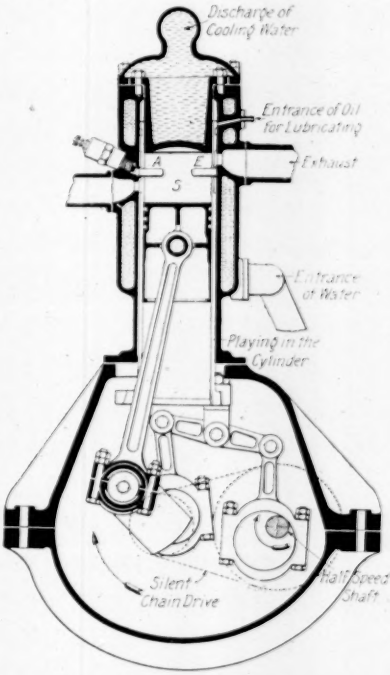

FIG. 2 ROLLAND-PILAIN MOTOR

BEITRAG ZUR FRAGE DER ABWÄRMEAUSNUTZUNG BEI GASMASCHINEN, C. Semmler. *Dinglers Polytechnisches Journal*, January 20, 1912. 3 pp., 7 figs. *b.* A modern double-acting large gas engine consumes about 2400 WE (about 9600 B.t.u.) per second per effective horsepower, this amount being utilised as follows: 26 per cent for effective work, 5 per cent in mechanical losses, 35 per cent in losses in water cooling, 34 per cent in losses due to exhaust, etc. The author describes an arrangement invented by himself for *utilising* the last two items, i. e., *heat now lost in water cooling and exhaust*, but first calls attention to the fact that in the present gas engines the cooling water is heated to about 60 deg. cent. (140 deg. fahr.) at atmospheric pressure, and that this leads to the formation of

considerable amounts of steam at the contact with the hot cylinder walls, and consequent low efficiency of cooling, the latter being made still lower by the formation of scale due to the use of imperfectly clean water. The arrangement used by the author is shown in Fig. 4, where M is the engine cylinder, and K a boiler with a pressure of ½ atmosphere above atmospheric, and temperature about 110 deg. cent. (230 deg. fahr.), the water level in the boiler being about 10 m. (say 40 ft.) above the motor. The water pressure in the cylinder jacket is therefore equal to about two atmospheres, and the boiling point about 120 deg. cent. (248 deg. fahr.). If the water is sent from the boiler, by the pump P, through the cylinder jacket

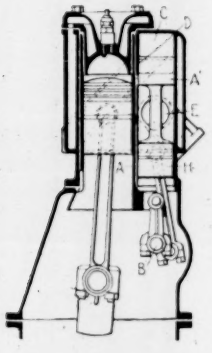

Fig. 3 Miesse Motor

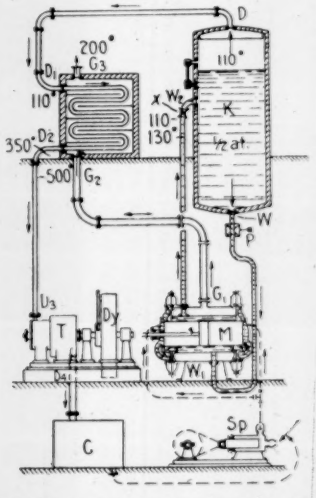

Fig. 4 Semmler's Arrangement for Utilizing Waste Heat of a Gas Engine

at such a rate that it has time to heat from 110 deg. to 115 deg. (239 deg. fahr.), there will be no formation of steam around the motor, but steam will freely form at W_2, where there is practically no water pressure. The formation of steam in the way desired can be made still more certain by making the pressure around the motor equal to, say, 5 atmospheres (corresponding to a boiling point of 151 deg. cent. or 303.8 deg. fahr.). This can be attained by reducing the cross-section at W_2. This arrangement permits the conducting of all the heat in the cooling water to the boiler K. The steam produced in the boiler is then led to the superheater U, and heated there by the exhaust gases of the motor having a temperature of 400 to 500 deg. cent. (752 to 932 deg. fahr.) and following the path $G_1G_2G_3$. The steam is superheated to about 300 or 350 deg. cent. (575 to 662 deg. fahr.), and conducted along the path DD_1D_2 to a low pressure steam turbine T which may drive a dynamo D_y. From the turbine the steam is led through D_4 to a surface condenser C, and the water of condensation returned to the boiler K by means of the feed-pump S_p, passing partly around the motor, and thus both cooling the motor and being pre-

heated itself. Since only chemically pure water is used, and no formation of steam in the cylinder jacket is allowed, a very intensive cooling is obtained, and all trouble with scale is avoided.

The author proceeds to show that the same system may be used not only for individual motors, but for groups, and that about 3000 additional effective h.p. may be obtained by this method from an installation having 20,000 h.p.

DER DIRECT UMSTEUERBARE SCHIFFSDIESELMOTOR DER RHEINISCHEN GASMOTORENFABRIK, A.-G. BENZ & CIE., MANNHEIM, Ch. Föhlmann. *Electrotechnische Zeits.*, January 25, 1912. 2 pp., 4 figs. *b.* Description of the *Diesel reversible marine engine*, designed by the Swedish engineer Hesselman, and now manufactured by Benz & Co. in Germany. It is a two-cycle engine without poppet valves, with two or four working cylinders, and two double-acting scavenging pump cylinders, the latter serving at starting for the purpose of manoeuvering. It is claimed that this construction

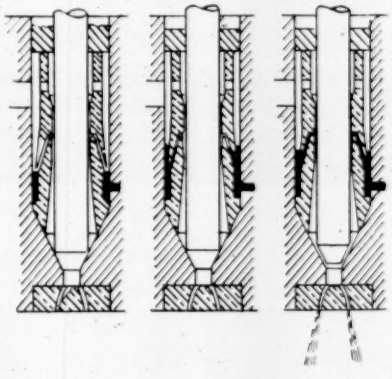

FIG. 5 HESSELMAN ATOMISER OF THE HESSELMAN-BENZ REVERSIBLE DIESEL ENGINE (BLACK LINES SHOW PATH OF FUEL)

has the following advantages: (*a*) the air pressure in the manoeuvering cylinders may be as low as desired, since it is absolutely independent of the degree of compression in the working cylinders; (*b*) immediately after the reversal of the direction of motion, the working cylinders may be set on ignition, while the manoeuvering part still works with compressed air: the engine then rapidly reaches the required speed of rotation, and the consumption of air is very low. The atomiser is built into the fuel valve. It is built on the principle that as the fuel is converted from a viscous liquid into a fluid foggy stream, the angle made by the edges of the atomiser and the area of its cross-section must both increase: a viscous liquid is best atomised by throwing it against sharp edges, while a fluid stream is more effectively broken into spray when striking broader surfaces. In accordance with this, the Hesselman atomiser is provided first with a sharp edge, then with two edges forming nearly right angles, and finally, near the needle, with an edge making an obtuse angle, in addition to which there is some extra space left in front of the nozzle plate. This construction (Fig. 5) produces, as the author claims to have seen personally, an

uncommonly low consumption of combustible for an engine without poppet valves (no figures are given), and an absolutely smokeless combustion.

Machine Shop

DIE VERZINKUNG NACH DEM SCHOOPSCHEN METALLSPRITZ-VERFAHREN, M. U. Schoop. *Acetylene*, No. 1, 1912. 6 pp., 16 figs. *b.* NOUVEAU PROCÉDÉ DE MÉTALLISATION DU DR. SCHOOP. *H. de F. Bulletin technique de l'Association des Ingénieurs sortis de l'École Polytechnique de Bruxelles*, December, 1911. 2 pp. *b.* Description of and some data on the *Schoop process of metallisation* (galvanising). The process is a further development of Sherardisation, and consists in projecting on the object intended to be metallised a liquid metal in such a fine spray and with such a velocity that the metal is reduced to a state of intangible fog. To do this the metal is melted in special crucibles, out of which it flows in a thin stream by its own gravity or under air pressure, and this stream is further broken into a spray and projected forward with great velocity by a jet of steam or other fluid. Although the metal is really in a molten state, the temperature of the "fog," probably owing to the cooling effect of the expansion of the gas in the carrying jet, is so low that it was found possible to metallise lace without injuring it. The layer of metal is said to adhere very well, and to be of great hardness and uniformity of structure. Professor Kaiser-Paris claims to be able to preserve eggs for an indefinitely long time by this process.

NEUE ARBEITSWEISE BEIM EMAILLIEREN, P. *Metall-Technik*, January 13, 1912. ½ p. *b.* The new process of Septimus and Albin Sonntag is claimed to be a simple and certain method of uniformly *enamelling metallic objects*, irrespective of shape or size. The surface of the object is uniformly moistened by placing the object in a vapor bath, or playing upon it with a stream of vapor (dipping the object in water does not produce uniform moistening, because metals are apt to repel unatomised water); enamel powder is then strewn over the object through a sieve, and sticks uniformly all over it; to put on a second layer of enamel powder the process is repeated. After the powder is laid on, the object is placed in the furnace as usual. It is claimed that the absence of fluxes or binders of any kind helps the enamel to preserve its color, brilliancy and transparency.

TOUR À CHARIOTER ET À FILETER POUR ACIER, À COUPE RAPIDE, H. Ernault. *Portefeuille économique des machines*, January, 1912. 1 p., 1 fig. and 1 plate of drawings. *b.* Describes an *engine lathe* with screw cutting attachment, with detailed drawings of same. The lathe is made with extreme precision.

MACHINE À RETREINDRE LES TIGES ET TUBES MÉTALLIQUES SYSTÈME BLISS, M. Lunet, *Le Génie Civil*, January 27, 1912. 2 pp., 11 figs. *b.* Describes a machine manufactured by E. W. Bliss Co., of Paris, France, for *reducing the diameter of metal rods and pipes*. The rod or pipe is placed between two metal members rotating about a centre on the axis of the rod or pipe. While rotating, the two members by radially projecting pieces strike a series of cylindrical rollers disposed along the path of rotation, and then

by recoiling rapidly and uniformly strike the piece which has to be reduced in diameter. When the piece is heavy, and strokes in very rapid succession might not prove convenient, the rollers against which the projecting pieces strike are disposed in a sort of cage, which is free to rotate with the striking members. When the roller is struck it, together with the striking member, moves a little, producing thereby a powerful pressure instead of a short, sharp stroke. The machine appears to be simple in construction, and is claimed to be efficient.

DAS FRÄSEN VON ZAHNRÄDERN. C. Brückner. *Zeits. des Vereines deutscher Ingenieure*, December 30, 1911. 3 pp., 2 figs. *f.* Discusses *gear cutting* with special attention to the question of cutting speed and rate of feed. Article includes tables.

EINE FLÜGELBOHRMASCHINE VON ERNST SCHIESZ IN DÜSSELDORF. Nickel. *Zeits. des Vereines deutscher Ingenieure*, December 30, 1911. 1 p., 1 fig. *b.* Describes a *radial drilling machine* built by the above named concern.

LE ZINGAGE DU FER ET DE L'ACIER. Sang. *Revue de métallurgie*, January, 1912. 34 pp. *h.* Discussion of various methods of *galvanising iron and steel*, and testing the quality of the material produced. The article is of a general nature, and is an introduction to a more detailed discussion of the three main methods of galvanisation by molten zinc, electrolysis and sherardisation, which will follow.

Mechanics

NOTE SUR LA THÉORIE DES ENGRENAGES. Garnier. *Revue de mécanique*, December, 1911. 22 pp., 21 figs. *h.* End of an investigation on the theory of *gearing*.

ÜBER SCHMIERMITTEL. Franz Hellbig. *Braunkohle*, January 12, 1912. 2 pp. *h.* A popular discussion of the problem of *lubrication*.

LE CATENE RENOLD PEL COMANDO DI REGOLATORI ED ALBERI DI DISTRIBUZIONE. *L'Industria*, January 17, 1912. 2 pp., 6 figs. *b.* Describes some British applications of *Renold's silent chains* for driving governor and sideshafts.

DAS HYDRODYNAMISCHE GETRIEBE VON FÖTTINGER. H. Hoff. *Stahl und Eisen*, January 11, 1912. 7 pp., 14 figs. *b.* Describes latest types of Föttinger's *hydrodynamic transmission*, mainly with regard to the possibility of its use in metallurgy. With a ratio of transmission of 1:5, a total efficiency of 0.87 was reached, and the efficiency rose to 0.97 for a ratio of transmission of 1:1.

DIE VERTEILUNG DES SENKRECHTEN RADIALDRUCKES AUF DIE KUGELN EINES KUGELLAGERS. Th. Lehmbeck. *Zeits. des Mitteleuropäischen Motorwagen Vereins*, End December, 1911. 3 pp., 4 figs. *c.* Investigation of the distribution of vertical radial pressures among balls in *ball bearings* made by the author in the Laboratory of the German Arms and Munition Factories, with a table of data obtained. The distribution of pressures does not agree with theoretical calculations, and exceeds it sometimes by 25 per cent. The distribution of pressure is not so unfavorable, as was asserted, that two or three balls carry the whole vertical radial pressure. The

author found that from four to five balls carry the pressure, and four of them carry considerable loads.

STATISCHE BERECHNUNG FLACH GEWÖLBTER GASBEHÄLTERKUPPELN FÜR EINSEITIGE SCHNEELAST, J. Schmidt. *Journal für Gasbeleuchtung*, December 30, 1911. 7 pp., 22 figs. *cf.* Method of determining the shape of a *flat arch roof* of a *gasholder* with regard to its ability to support a snow load. The method applies only to Schwedler flat arch roofs. A full solution of one example is given in the article.

RÉSISTANCE DES PIEUX, J. Benabenq. *Annales des Ponts et Chaussées*, September to December, 1911. 150 pp., 34 figs. *ccA.* Partly mathematical, partly experimental investigation of the forces acting on, and resistance of, *piles*, both statically and dynamically. The author shows that the statical method is both exact and general, and ought to be applied as a rule, both for the calculation of straight and of screw piles. Dynamic formulae are only approximately correct, and can be used only for the case when the pile goes down to bottom rock. The author proposes a new formula sufficiently correct for this case. (For a shorter abstract see Génie Civil, Jan. 27, 1912, article by Ch. Lantin.)

ÜBER DEN MECHANISMUS DES FLÜSSIGKEITS- UND LUFTWIDERSTANDES, Th. von Kármán und H. Rubach. *Physikalische Zeits*, January 15, 1912. 10 pp., 3 figs. *ch.* Mathematical investigation of the *resistance of liquids and air* when this resistance is proportional to the square of the velocity, which happens when the velocity is considerable. The values analytically obtained by the author agree fairly well with those obtained experimentally by Föppl and Eiffel.

Steam Engineering

SUR UN COMPTEUR DE VAPEUR, H. Parenty. *Comptes rendus des séances de l'Academie des Sciences*, January 2, 1912. 2 pp., 1 fig. *bd.* The author claims that all the *steam meters* recently placed on the market in France are adaptations of his formulæ and meter designed as early as 1886. The drawing shows his piezometric meter with density compensator, based on the formula for the output of a fluid:

$$H = 3600\ mS\ \sqrt{2\ g\ (p_o - p_1)} \times \sqrt{\gamma_o}$$

where mS is the area of the orifice, p_o-p_1 fall in pressure, not above 0.1 of the initial pressure p_o, and γ the density of the fluid. The correctness of this formula for gases has been proved by J. Bousinesq (Comptes rendus, t. 138).

UNTERSUCHUNGEN AN ELEKTRISCH UND MIT DAMPF BETRIEBENEN FÖRDERMASCHINEN. *Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens*, vols. 110 and 111. 104 pp., 105 figs., 2 tables. *aA.* A detailed investigation of the comparative cost and efficiency of *steam and electric drive for winding engines*. The general conclusion is that in selecting a system of drive there must be taken into account other conditions than cost, and the system of driving the winding engines must fit in with the rest of the equipment of the mine.

TURBO-KESSELSPEISEPUMPE. *Zeits. für Dampfkessel und Maschinenbetrieb*,

December 29, 1911. 4 pp., 3 figs. *b.* Description of, and data on, a *turbine-driven feedwater pump* built by the German General Electric Company.

UNTERSUCHUNG EINES GERISSENEN FLAMMROHRSCHUSSES. E. Heyn and O. Bauer. *Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens*, vol. 112. 22 pp., 36 figs. *cA.* Investigation of the causes why a *flue ring* broke in a boiler. The tests were made at the Royal Laboratory at Gross-Lichterfelde-West for a private concern, and show the method of work at that laboratory, and the thoroughness of it.

VERDAMPFUNGSVERSUCH AN EINEM RAUCHGASVORWÄRMER (EKONOMISER) Bauart Schultz D. R. P., Georg Lehmann. *Zeits. für Dampfkessel und Maschinenbetrieb*, January 12, 1912. 2 pp. *c.* Data of evaporation test

TABLE I DATA OF ECONOMIZER TESTS

	Green	Düsseldorf	Kruger	Schultz	
	Mean of Seven Tests			Test 1	Test 2
Surface of the feed-heater, qm.	48.2	48.2	48.2	40	40
sq. ft.	518	518	518	430	430
Water evaporated per hour, kg.	1128	1148	1150	2042	1510
lb.	2480	2525	2530	4500	3320
Temperature of water t_1 at entering the feed-heater, deg. cent.	35.5	37.3	37.6	55	47.5
deg. fahr.	95.9	99.2	99.6	131	117.5
Temperature of water t_2 at leaving feed-heater, deg. cent.	105.7	105.7	105.9	130.7	138.3
deg. fahr.	222.3	222.3	222.6	267.3	281
Temperature of main flue gases T_1 at entrance in feed-heater, deg. cent.	228	234	225	436	384
deg. fahr.	442.4	453.2	437	817	723
Temperature of main flue gases T_2 at leaving feed-heater, deg. cent.	164	161	171	203	207
deg. fahr.	327.2	321.8	339.8	397.4	404.6
Carbon dioxide in the gases at entering feed-heater, per cent.	6.2	6.2	5.9	10.28	8.55
Coefficient of heat transmission k	11.05	13.37	11.63	17.05	16.94
Heat taken up by feed-heater in WE per qm.	1468	1580	1585	3865	3437.8
B.t.u. per sq. ft.	543	585	587	1430	1271

with a *Schultz economiser* made in 1911 in a brewery in Glogau, Germany. Table 1 gives the main data of these tests, compared with the data of tests, made in 1910 by the Bavarian Association for the Inspection of Boilers, on a Green, a Düsseldorf, and a Krüger economiser. (Ср. Zeit für Dampfkessel und Maschinenbetrieb, February 16, 1912.)

QUELQUES SURCHAUFFEURS. *Revue de mécanique*, December, 1911. 32 pp., 46 figs. *b.* Description of *superheaters*, mainly British and American types, which appeared on the market during the last three years, with a

list of articles on superheaters in the Revue de mécanique during the last fifteen years covering practically every patent during that time.

La turbo-soufflante (système Rateau) des hauts fourneaux de Vizcaya, A. Rateau. *La Technique moderne*, January, 1912. 3 pp., 3 figs. *b*. Description of a *Rateau mixed turbine and blower* installed in a blast furnace plant in Vizcaya, Spain. The same article was printed in German in Zeits. des Österr. Ingenieur- und Architekten-Vereines, October 6, 1911, under the title, Turbogebläse, System Rateau, für die Hochofen von Vizcaya.

De l'alimentation dans les chaufferies, J. Guillaume and A. Turin. *La Revue électrique*, January 12, 26 and February 9, 1912. 6½ pp., 10 figs. *bf*. A rather elementary, but very clear, description of *feeding* in boiler plants, with special regard to central station work. May be useful as a basis for lectures to employees.

Les bourrages métalliques et les bourrages souples. *Fer et Acier*, December, 1911. 2 pp., 2 figs. *b*. General discussion of what conditions a good packing for piston rings must satisfy, with a description of the Zimmermann *self-lubricating packing*. This packing is made of a rope impregnated with the lubricating substance, with a perforated metal ribbon spirally wound around the rope. The purpose of the perforations in the winding is to let the lubricating substance through, while the combination of the rope and metal ribbon around it is claimed to make the packing extremely flexible, and at the same time as strong as metallic packing.

Eine neue selbstständige Vorrichtung zur Bestimmung des Kohlensäuregehaltes in Rauchgasen, Ernst Müller. *Zeits. des Vereines deutscher Ingenieure*, December 30, 1911. 3½ pp., 7 figs. *b*. Describes a new apparatus for measuring the *contents of carbon dioxide* in gases of combustion based on the measurement of heat produced by the absorption of carbon dioxide by solution of caustic potash. The rise of temperature is recorded thermoelectrically, and the contents of carbon dioxide can be read directly.

Séparation de l'huile des eaux de condensation par l'électrolyse. Électro, December, 1911. 2 pp., 3 figs. *b*. The Halvor Breda process for *separating the oil from the water of condensation* is based on the property of the electric current to destroy, in passing through water, the oil emulsion, and to assemble the oil particles into flakes which can be mechanically separated from the water. A certain number of iron plates placed in a wooden vessel serve as electrodes; the water of condensation is made to flow between these electrodes, and the current passing through it destroys the emulsion, and drives the oil particles together into flakes; the water then passes through a gravel filter, and comes out clear and free of oil. The apparatus works automatically, and requires practically no attendance.

Recherches sur l'ébulition dans les générateurs de vapeur, M. Émanaud. *Le Génie Civil*, January 6, 1911. *c*. The purpose of this investigation was to *see how boiling occurs in closed vessels with metal surfaces of evaporation*. A Papin digester was constructed with two peep-

holes, 60 mm. (2.36 in.) in diameter, covered by chrome glass 10 mm. (0.39 in.) thick, and provided with a safety valve, air escape cock, and manometer. The bottom of the digester was in the form of a truncated cone high enough for the top of the trunk to be conveniently observed through the peep hole. Except for the surface of evaporation the interior of the digester was enameled to prevent oxidation of the walls, and coloring of the water that it would lead to. The digester was heated by a Bunsen burner placed below it, and covered with non-conducting material to prevent heat losses. It was supposed to contain 12 kg. (26.4 lb.).

Boiling in a Closed Vessel. When water is heated in this apparatus with the air escape cock open, boiling begins at about 100 deg. cent. (212 deg. fahr.); then, with the air escape cock closed, the *boiling continues* with the temperature rising as the pressure rises, contrary to what books on physics tell. The boiling goes on with greater intensity as the heating is made stronger, and the digester is less protected from heat losses. The author explains it by the supposition that the temperature is not uniform throughout the mass of the water, and that there is no real correspondence beween the tension at the free surface of the liquid and its temperature. As regards steam generators this shows that internal circulation may start as soon as the whole mass of the water has reached a temperature in the neighborhood of 100 deg. cent. (212 deg. fahr.), and there is an internal circulation, slow but real, during stops and periods of raising the pressure, a fact that may be of interest for heating of boilers, especially those which do not have free expansion.

Size of Steam Bubbles. For a good circulation the steam bubbles must be small. Observation has shown that the size of the bubbles depends on the nature of the liquid and surface of evaporation, and on the regularity of the process of boiling. When pure water is boiled over a clean metal surface, the bubbles are remarkably uniform in size, while in a carefully cleaned glass flask, where ebullition is difficult, both large and small bubbles appear. With given conditions of ebullition, the size of the bubbles appears to be independent of the pressure, but increases with the demand for vapor, or rate of evaporation, or, what amounts to the same thing, retardation of ebullition, or with the difference between the average temperature of water at the contact with the surface of evaporation and the temperature for which the manometric pressure would correspond to the maximum tension of saturated vapor. As regards the absolute dimensions of the bubbles, in pure water boiling over clean metallic surfaces, the bubbles are very small, about 1 mm. (0.039 in.) in diameter. But a very thin layer of graphite grease or oil on the surface of evaporation produces at once an approximately five-fold increase in the size of the bubbles. Pure graphite in flakes does not produce this result.

Formation of Bubbles. The formation of bubbles depends on the state of capillary equilibrium between the liquid, the vapor and the surface of evaporation. Thus, if a part of the surface of evaporation is polished, no vapor bubbles are formed on that part, although boiling goes on around it. The author explains it by the supposition that a higher temperature is necessary to produce boiling on a polished surface. If, instead of water, a

solution of some calcium salt is heated, which easily gives a precipitate, the nature of the surface is modified, and boiling goes on in a regular manner, i. e., all over the surface. That probably explains why marine boilers using sea water steam worse when new.

The author recommends the use of the apparatus described for the study of the action of materials recommended for the prevention of scale and of paints intended for the prevention of corrosion of boiler plates. The apparatus does not appear to have been patented.

Déshuileur de vapeur d'échappement système Massip. *La Revue électrique*, January 26, 1912. 1 pp., 3 figs. *b.* Description of an *oil separator for exhaust steam*, Massip system. The stream of steam is divided into very thin layers by two groups of fixed curved partitions, all of the same curvature, and at equal distances from each other. These partitions are provided with vertical projections, with grooves at the bottom, and the particles of oil striking against these projections are stopped by them, and are finally forced to flow along the grooves and out of the apparatus.

Tests made at the central station of the Paris Gas Company at Landy

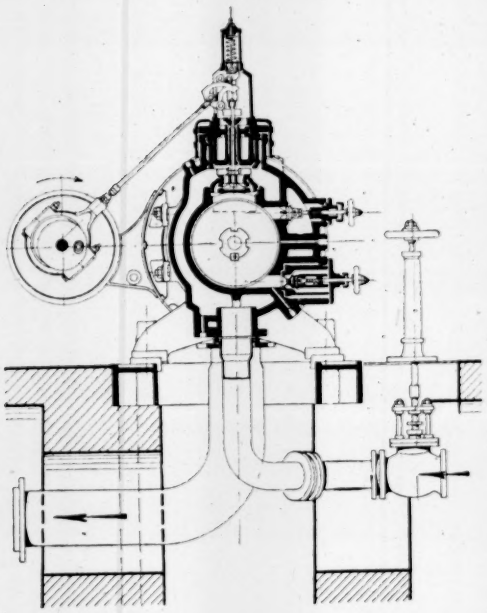

Fig. 6 Straight-Flow Steam Engine, Arrangement of Valves

have shown that, when installed with two 650-h. p. engines, the oil separator produced a loss of pressure of 115 mm. (4.4 in.) of water, and that the water of condensation contained only 1.5 mg. of oil per liter coming from the apparatus, against 500 mg. per liter which it had on entering.

ERGEBNISSE DER ABNAHMEVERSUCHE EINER Z-M.-GLEICHSTROM-DAMPFMASCHINE, Karl Benecke. *Zeits. für Dampfkessel und Maschinenbetrieb*, December 15, 1911. The tests were made by the Saxony (Germany) Associa-

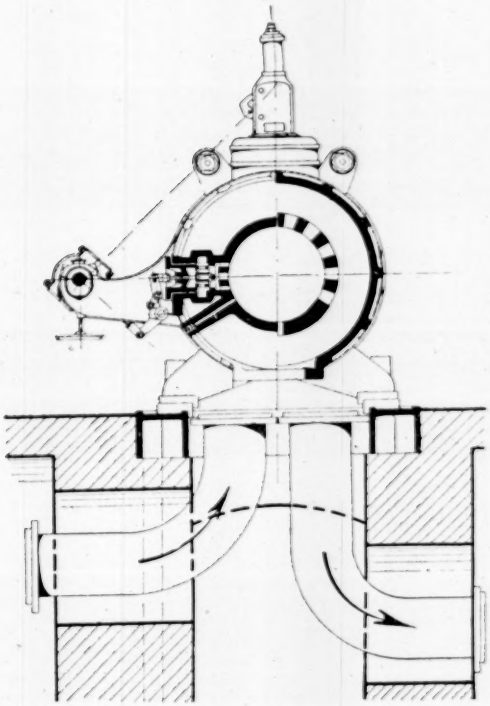

FIG. 7 STRAIGHT-FLOW STEAM ENGINE AUXILIARY EXHAUST GEAR

tion for the Inspection of Boilers. The machine under test was a 380-h.p. straight-flow steam engine having the dimensions:

	Crank side.	Cover side.
Cylinder diameter, cold measured mm. in	720/28.3	720/28.3
Cylinder diameter, hot, calculated mm	720.9	720.9
Piston-rod diameter, mm./in	142/5.59	140/5.51
Piston working area F, qcm./sq. in	3921.293/607.75	3925.723/608.4
Stroke s, mm./in	900/35.43	900/35.43
Constant $\frac{F.\ s.}{60.75}$	0.78426	0.80737
Sum for both sides of the piston	1.59163	
Volume swept by piston per stroke, l/cu. ft	353.11	353.51
Average volume swept by piston per stroke, l/cu. ft	353.31	
Ratio of cylinder volumes	1	
Clearance, l	8.47	9.19
$\frac{\text{Clearance}}{\text{Volume swept by piston per stroke}}$ per cent	2.4	2.6
Average clearance, l	8.83	

The general arrangement of the valve gear is shown in Fig. 6. It is built on the principle of the Lentz or Proell valve gear, with the difference that the cam opening the valve does not act directly on the pulley connected with the valve stem, but an intermediate lever is inserted. This eliminates the considerable side pressures of the Lentz valve gear.

Fig. 7 shows the novel arrangement of the auxiliary exhaust gear. Prof. Stumpf in his book, Die Gleichstrom-Dampfmaschine (1911, p. 49), states that each condensing, straight-flow steam engine should be provided with a reserve clearance space, in order to facilitate the starting of the engine in case the condensor pump is out of commission, and to make possible the work of the engine without condensation. Experiments made by the Zwickauer Maschinenfabrik have shown that increase of clearances in non-condensing steam engines leads to considerably increased consumption of steam, and is, therefore, not economical (the article contains data of one of these experiments). The principle of the auxiliary exhaust gear shown in Fig. 4 consists in placing at the ends of the cylinders two auxiliary exhaust valves actuated by a separate eccentric, and arranged so that their cycle of action can be set in accordance with the steam pressures and temperatures. The driving eccentric transmits by means of a link its motion to an intermediate shaft carrying the cranks acting on the auxiliary exhaust valves. In passing from working condensing to working non-condensing and *vice versa* all that is necessary is to throw in or out this link. In the last type this link is connected with the wheel of the two-way valve in such a manner that when the engine is set for working non-condensing, the auxiliary exhaust gear is cut in. The results of the test are given in the following tabulation:

Beginning of test		9 hr. 33 min.
End of test		3 hr. 58 min.
Duration of test		6 hr. 25 min.
R. p. m.		106.37
Average piston speed, in. per sec.		3.191
Steam pressure above atmosphere:		
in boiler	kg/qcm	10.25
	lb. per sq. in.	145.75
at boiler side of stop valve	kg/qcm	9.8
	lb. per sq. in.	139.35
at entrance to steam cylinder:		
crank side	kg/qcm	9.8
	lb. per sq. in.	139.35
cover side	kg/qcm	7.9
	lb. per sq. in.	112.34
Temperature of steam:		
at superheater, cent./fahr.		207.5/405.5
at entrance to engine, cent./fahr.		118/370.4
superheat, cent./fahr.		6/10.8
Cut-off (cylinder), per cent		about 6.5
Vacuum:		
maximum value in diagram	kg/qcm	0.88
	lb. per sq. in.	12.53
In condenser, cm./in.		66.9/26.5
Water and air:		
temperature of condenser injection water, cent./fahr.		17/62.6
temperature of condenser return water, cent./fahr.		33/91.4
barometric pressure of air, kg/qcm/lb. per sq. in.		1.005/14.29

Power:		
total power, I.h.p.		324.68
cylinder	crank side	181.69
	cover side	142.99
average indicated pressure, crank side	kg./qcm	2.178
	lb. per sq. in.	30.97
average indicated pressure, cover side	kg./qcm	1.665
	lb. per sq. in.	23.60
*Steam consumption:		
total consumption of feedwater, kg./lb.		12777/28409
consumption of water per hour, kg./lb.		1991.16/4380
consumption of steam per h.p.-hr. apart from water of condensation from steam supply, kg.		6.13
	lb. per h.p.	13.4
*Heat account:		
total heat of saturated steam entering engine, WE per kg./B.t.u. per lb.		666.9/1200.4
total heat of superheated steam entering engine, WE per kg./B.t.u. per lb.		660.4/1188.7
heat of steam consumed per h.p.-hr, WE per kg./B.t.u. per lb.		4109.6/7397.3

OBSERVATIONS ET FORMULES RELATIVES A L'ÉCOULEMENT DES FLUIDES ÉLASTIQUES, Maurice Leblanc. *La lumière électrique*, December 16, 1911; January 20, 1912. *ch.* A jet of steam was propelled from a nozzle into a diffuser (and condenser), the jet passing on the way through a closed vessel where a high vacuum was maintained. The vessel was lighted, and a peep-hole provided to permit inspecting the interior. If the steam was dried in a separator, the jet was invisible; if not, the jet was opaque. The jet was introduced at a pressure of 6 kg/qcm (85 lb. per sq. in.), the nozzle arranged to expand it to 2 mm. of mercury, while the pressure in the vessel was only 1 mm. of mercury.

The opaque jet of wet steam had the appearance of a rigid rod, at first cylindrical, but drawn out to a point as it penetrated into the diffuser where the pressure increased gradually and directly as the distance from the entrance (Fig. 8). This drawing out was observed only inside the diffuser, while between the outlet of the nozzle and the entrance of the diffuser the jet appeared to be cylindrical, showing that the contraction observed is real, due to the increase of pressure, and not merely apparent, as would have been the case if the superheating of the steam was caused only by friction.

There was another striking phenomeno: : large drops of water which fell from the top of the vessel on the jet did not pass through it, and were not carried with it, but rebounded from it as if they had struck an iron rod. The density of the jet was about 900,000 times less than that of the water drops, but the velocity of translation of the fluid was at least 1300 m. (4265 ft.) per min. The same happened when the steam was dry and the jet invisible; the drops of water were not carried away by the jet, but glided along it as if it were an iron rod, and when the jet was let into an exhausted glass bell, the jet could not be seen, but, on looking through the bottom, a circle formed by the projections of the water drops was plainly visible.

When a fluid jet suddenly passes from a medium at a higher to one at a lower pressure, the different stream lines of the jet do not diverge all the time and form a sort of a cone, as one would expect. The jet, after several expansions and contractions, rapidly recovers its cylindrical form, and the stream lines get close

* Correction for the difference between American and German horsepower has been made in Steam consumption and Heat account.

together again, there being a tendency in the jet to have at each moment the smallest cross section possible. The jet acts as if it were encased in an elastic sheath, or as if its surface were subject to surface tension. It seems to the author therefore that a jet having a great velocity, *has an individuality of its own, and is always clearly distinct from the surrounding medium*, even if it be solid walls of a passage through which the jet flows. In general, the limiting surface of the jet is different from that of the enclosing passage, and there is a ring of eddies between them. The author concludes: (*a*) at all points of a section normal to the axis the pressure as well as the velocity of the separate stream lines in the fluid remain practically constant with a slight increase towards the center. One can apply to it the hypothesis of layers and the formula of Saint-Venant,[1] pro-

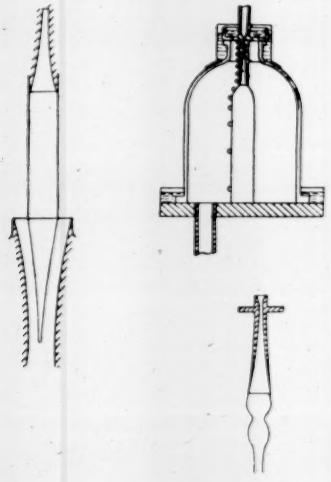

FIG. 8 STEAM JET IN EXHAUSTED VESSEL AND DIFFUSER; BEHAVIOR OF WATER DROPS TOWARDS STEAM JET; CHANGE OF FORM OF JET WITH CHANGE OF PRESSURE

vided the layers are limited by the surface of the jet, and not by the walls of the passage through which the jet flows; (*b*) the friction at the surface of the jet is small if it is exerted against a fluid at rest, or against a smooth metal surface, but becomes considerable when the fluid has a velocity of translation comparable to that of the jet, and especially if it eddies around it. The author proceeds to prove, from the formulæ of Saint-Venant and Weisbach,[1] that when a fluid jet passes from a medium at a certain pressure P_1 to another medium at an inferior pressure P_2, it contracts as long as the velocity of the fluid is less than that of sound, and begins to expand as soon as its velocity exceeds that of sound, the velocity of the jet being greater than that of sound when the ratio $\frac{P_2}{P_1}$ is less than $\left(\frac{2}{1+\alpha}\right)^{\frac{\alpha}{\alpha-1}}$. The exponent α in the adiabatic equation $PV^{\alpha}=\text{constant}$ is constant for each fluid, but variable from one fluid to another. It follows from this

[1] For Saint-Venant's formula see H. H. Suplee, The Gas Turbine, 1910, p. 181. Formula (5) on the same page is Weisbach's formula.

that when the ratio of expansion $\frac{P_2}{P_1}$ is greater than $\left(\frac{2}{1+\alpha}\right)^{\frac{\alpha}{\alpha-1}}$, or than $\frac{P}{P_1}$, where p is the pressure at the minimum of cross-section, the nozzle must be simply converging; if it is less, the nozzle must be converging-diverging. For air this ratio[1] is 0.526, and for saturated dry steam, at the beginning of expansion, it is (according to Zeuner $\alpha = 1.135$) 0.580. If the steam is wet at the beginning, and its quality is x, then

x	α	$\frac{P}{P_1}$
1	1.135	0.5774
0.9	1.125	0.5795
0.8	1.115	0.5815
0.7	1.103	0.5840

the values of α being determined by the empirical formula valid for x between 0.7 and 1

$$\alpha = 1.035 + 0.100x$$

Determination of the Smallest Cross-Section of a Nozzle for a given Output. The inlet opening of a nozzle may be as large as possible, but the outlet opening in a converging nozzle, or the "neck" of the converging-diverging nozzle have to be of definite dimensions to give a given output at maximum efficiency. The nozzle is supposed to have exactly the form of the jet.

Converging Nozzles. A fluid having a specific weight ω, at pressure P_1 (i. e. 1 cu. m. of the fluid at pressure P_1 weighs ω kg.) flows through a converging nozzle into a space having a pressure P_2 smaller than P_1 but greater than

$$P_1\left(\frac{2}{1+\alpha}\right)^{\frac{\alpha}{\alpha-1}}$$

both pressures being in kg. per sq. cm. (to convert them into lb. per sq. in. multiply by 14.22); the output, in grams per sec. per sq. cm. of the section of the opening, is given by the formula

$$J = 10\left(\frac{P_2}{P_1}\right)^{\frac{1}{\alpha}}\sqrt{\frac{2g\alpha}{\alpha-1}\omega_1 P_1\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{\alpha-1}{\alpha}}\right]}$$

and the efflux velocity of the fluid in the outlet is, in meters per second

$$W_2 = 100\sqrt{\frac{2g\alpha}{\alpha-1}\frac{P_1}{\omega_1}\left[1-\left(\frac{P_2}{P_1}\right)^{\frac{\alpha-1}{\alpha}}\right]}$$

These formulae are applicable only to homogeneous fluids, and do not generally hold good for a mixture of steam and water.

Converging-Diverging Nozzles. The output of such a nozzle depends only on the initial pressure P_1, since P_2 must be less than p, or there would be no need for using such a nozzle.

Longitudinal Section of a Diverging Nozzle. The angle of cone of the nozzle was often made constant. This can be done in steam turbines, where the steam is not expanded beyond a certain limit, but would require the use of incon-

[1] L. Sekutowicz (Mémoires de la Société des Ingénieurs Civils de France, 1906, p. 268) gives this ratio as 0.529.

veniently long and very wasteful nozzles in the ejectors of the refrigerating machinery where the expansion is carried to a very high degree. It is therefore well to know how to determine the most efficient longitudinal section of a diverging nozzle.

If the radius of a section of the nozzle normal to the axis at a distance x from the beginning be denoted by R, then the tangent of its angle of cone is $\frac{dR}{dx}$

From Saint-Venant's formula the author obtains the following equation:

$$\frac{dP}{dx} = \frac{P\alpha W^2}{R} \frac{\left[\eta - 2\frac{dR}{dx}\right]}{W^2 - W_s^2}$$

where W is the velocity of flow of steam, W_s the velocity of sound, and η a constant coefficient. This shows that in order to have

$$\frac{dP}{dx} < 0$$

when W is greater than W_s, it is necessary that

$$\frac{dR}{dx} > \frac{\eta}{2}$$

or, in other words, *the angle of cone* of a nozzle *must be the greater, the greater the coefficient of friction of the fluid against the walls of the nozzle.*

Leblanc has adopted the following rule for the design of the nozzles in his ejectors: the angle of cone which is at first, at the neck of the nozzle, equal to zero, changes rapidly until it becomes equal to 6 deg. It then remains constant until the steam attains the temperature corresponding to the pressure in the condenser into which the ejector opens; then the angle gradually grows up to the outlet orifice. The curvature of the walls of the nozzle is such that, in a section normal to the axis, the pressure is 10 per cent less at the periphery than at the centre.

In the following number will be given a description of the Leblanc refrigerating machine (Cp. Mémoires de la Société des Ingénieurs Civils de France, November, 1911, and Bulletin de la Société d'Encouragement pour l'Industrie Nationale, December, 1911).

Strength of Materials and Materials of Construction

KAUTSCHUK UND SEINE TECHNISCHE PRÜFUNG, K. Memmler. *Gummi-Zeitung*, January 12, 1912. 4 pp., 7 figs. *f.* Discusses methods of testing rubber, mainly on the basis of the practice of the German Royal Testing Laboratory at Grosz-Lichterfelde-West. It was found that tests for tensile strength with rubber bars placed in the grips of a testing machine in the way steel bars are placed gave quite unreliable results, and that a much better way was to punch or turn out a rubber ring with a rectangular cross section, place it belt-like over two pulleys, and draw the pulleys apart. For fuller account of the work done by the laboratory on rubber testing cp. *The India Rubber Journal*, November 25, December 2, 9, 1911.

ÜBER SCHALLDURCHLÄSSIGKEIT. *Tonindustrie-Zeitung*, January 23, 1912. ½ p. *h.* Account of an investigation of *sound conductivity* of different materials by R. Berger in Munich. The first part of the investigation

covers the problem of subjective and objective measurement of sound. In the second part Mr. Berger investigates mathematically the propagation of sound and its conduction in various bodies, showing, among other things, that to prevent the propagation of sound in one body another body must be used as an isolator, for which the product of thickness and velocity of propagation of sound is as much as possible different from that for the first body; telephone booths ought therefore to be lined with iron sheets, and not with felt. In the third part the influence of the material in walls on conductivity of sound is treated. Felt, carpets, etc., are good sound absorbers and poor conductors of sounds produced in the material itself, but easily convey sounds produced in the air. A reinforced concrete wall, on the contrary, is a poor conductor for sounds produced in the air, but will transmit through several floors the sound produced by hitting the wall with a hammer. Mr. Berger attaches considerable importance to the distinction between sound produced in the air and in the material itself.

DE L'ACIER FABRIQUÉ AU FOUR ÉLECTRIQUE. *Journal du four électrique*, January 15, 1912. 1 p. *f.* From a paper by Mr. Rodenhauser before the Chemical Association of Freiberg.

TABLE 2.—COMPARISON OF STRENGTH OF BESSEMER AND ELECTRIC FURNACE STEEL.

	Tensile Strength	Elongation, Per Cent	Limit of Elasticity	Reduction of Area, Per Cent
Bessemer Steel	38 to 44 kg. 84 to 97 lb.	22 to 24	28 kg. 62 lb.	50
Electric Steel (Kochling)	61 to 65 kg. 134 to 143 lb.	17 to 18.6	41.6 to 45.4 kg. 91.5 to 100 lb.	43.6 to 52

VERSUCHE MIT ALUMINUM GESCHWEISZT UND UNGESCHWEISZT, BEI GEWÖHNLICHER UND HÖHERER TEMPERATUR. R. Baumann. *Zeits. des Vereines deutscher Ingenieure*, December 12. The experiments were made with aluminum bars containing not less than 99 per cent pure aluminum; part of the bars were annealed and hammered, part welded, annealed and hammered, and part not annealed (Table 3).

At ordinary temperatures, tests for elasticity have shown that elongation and tension remain proportional to each other up to the following loads:

For annealed and hammered bars, 159 kg/qcm (2260 lb. per sq. in.)

For a bar which has been subjected before the test to a pressure of about 2500 kg/qcm (35551 lb. per sq. in.) 168 kg/qcm (2389 lb. per sq. in.).

Experiments for the determination of tensile strength, elongation at rupture, and reduction of area at ordinary and higher temperatures. The tensile strength decreases considerably and steadily as the temperature rises; cold rolled material shows even at higher temperatures a greater tensile strength than annealed and hammered bars; welded bars have a

TABLE 3 TEST OF STRENGTH OF ALUMINUM BARS

Thickness of Bar Mm. / In.	Length of Bar Mm. / In.	Annealed and Hammered Bars — Temperature, Deg.					Welded, Annealed and Hammered Bars — Temperature, Deg.				Unannealed Bars — Temperature, Deg.			
		Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.	Cent. Fahr.
		20 68	60 140	100 212	200 392	300 572	20 68	100 212	200 392	300 572	20 68	100 212	200 392	300 572
		Tension at Rupture in Kg/qcm—Lb. per Sq. In.												
17 0.668		927 13182		677 9627	384 5460	241 3427	1040 14788	760 10807	439 6243	305 4337	1506 21415	739 10508	471 6697	284 4024
12 0.472							1059 15059	845 12015	546 7764	330 4793				
8 0.314		1045 14860	884 12570	738 10494	397 5645	206 2929	1018 14480	764 10864	627 8916	266 3983	1417 20150	1230 17490	834 11859	315 4479
4 0.157		1016 14448		666 9470	482 6854	261 3711	1014 14419	755 10736	523 7437	286 4109	1270 18059	915 13011	644 9158	301 4280
		Elongation at Rupture, Per Cent												
17 0.668	50 1.968	53.8		79.2	92.8	(119.2)	40.4	(63.0)	65.8	(49.0)	14.5	61.1	78.0	81.2
	100 3.937	41.6		61.5	65.5	(87.0)	26.0	(49.4)	38.9	(24.0)	8.6	46.0	58.9	53.5
	200 7.874	33.5		51.4	47.7	(63.1)	18.9	(33.1)	20.0	(13.0)	5.1	37.2	46.5	39.6
8 0.314	60 2.362	38.6	49.9	61.3	78.0	70.8	25.2	41.7		(26.7)	11.8	16.3	20.8	48.8
	120 4.724	31.1	38.3	49.6	61.4	54.3	16.6	27.7		(17.1)	7.1	9.2	13.2	30.3
		Reduction of Area, Per Cent												
17 0.668		66.0		80.5	90.3	95.0	53.8	70.8	86.0	(68.6)	30.8	76.3	85.9	90.3
12 0.472														
8 0.314		65.9	71.9	75.0	84.4	88.9	63.5	78.0		83.8	50.9	53.0	68.1	81.4
4 0.157		90.8		74.4	86.8	94.6	55.0	69.5	79.8	92.3	49.4	68.8	76.9	79.5

higher tensile strength than annealed and hammered bars; there are, for the most part, no gaps at the welded places on the surface of rupture; welded bars have lower values for, and slighter increases of, elongations with the increase of temperature than bars not welded; the reduction of area increases with the temperature, and reaches extremely high values. The coefficient of hardness by Brinnell's method (load 500 kg., diameter of the ball 10 mm.) was found to be for unannealed bars 17 mm. (0.68 in.) thick, between 23.9 and 44.6 kg. per qmm. (33,985 to 63,421 lb. per sq. in.); for annealed bars of the same thickness 26.2 (37,256 lb. per sq. in.), and for welded bars 31.8 (45,220 lb. per sq. in.). Previous heating to 300 deg. cent. (572 deg. fahr.) reduced the hardness of annealed bars to 24.7 kg. per qmm. (35,023 lb. per sq. in.), that of welded bars to 27.5 (39,305 lb. per sq. in.), while the hardness of unannealed bars was found to be 23.5 (31,617 lb. per sq. in.).

For a notch shock test a groove of 1.3 mm. (0.0516 in.) in diameter cut along the flange served as a notch; the surface distance was 70 mm. (2.8 in.), cross-section 10 mm. x 5 mm. (0.0775 sq. in.). Annealed and hammered aluminum required for rupture a work of 4.3 mkg/qcm (200 ft.-lb. per sq. in), without a complete rupture of the bar taking place. A welded bar required a work of 3.7 mkg/qcm (172 ft.-lb. per sq. in.), and did not break completely, while the unannealed piece broke after 1.5 mkg/qcm (70 ft.-lb. per sq. in.).

Einfluss der Umschmelzung und Abkühlung auf die chemischen und mechanischen Eigenschaften von Lagermetallen, G. Goldberg. *Giesserei-Zeitung*, January 15, 1912. 2 pp. *c.* An account of tests made at the Royal Laboratory at Gross-Lichterfelde-West to determine how repeated melting, heating and cooling affects the chemical constituency and mechanical properties of *bearing-metal alloys*. It was found that repeated melting does not make substantial changes in the chemical composition of *white-metal:* the percentage of copper in the alloy increases by about 0.2 of 1 per cent. for each melting, but the ratio of tin and antimony remains the same, although the absolute percentage of these metals in the alloys decreased by about 1.4 per cent. after five meltings. It was further found that when white-metal is heated and then cooled, its mechanical strength is favorably affected by rapid cooling, and decreased by slow cooling: slowly cooled metal is about 10 per cent. weaker in compression than rapidly cooled, while in the upsetting test a work of 2.5 mkg/qcm (115 ft. lb. per sq. in.) was applied when cracks appeared in slowly cooled metal, and 13.75 mkg/qcm (633 ft. lb. per sq. in.) in rapidly cooled metal. The chemical composition of *gun-metal* alloys was affected by repeated meltings in the same way as that of white-metal, but its strength and elasticity were noticeably weakened by repeated meltings. The article is to be continued.

Neue Versuche über die Feuersicherheit des Eisenbetons, R. Saliger. *Tonindustrie-Zeitung*, January 13, 1912. 1½ pp. *c.* Describes experiments made at the Technical Institute in Berlin on *reinforced concrete as a fire resisting material*. Two little houses, 6 m. (about 20 ft.) long and 4 m. (about 13 ft.) broad and high, were built, filled with wood and

set on fire. In one house the reinforcing elements were embedded 0.5 cm. (0.196 in.) deep, in another 2 cm. (0.78 in.) deep, the houses being built partly of gravel concrete, partly of limestone ballast concrete. The fire was kept burning for 2 hours 20 minutes. The plastering began to fall off 4 minutes after the fire was started, when the temperature was still below 100 deg. cent. (212 deg. fahr.), thus showing its total uselessness. The difference in the depth of embedding the reinforcing elements did not appear to affect the strength of the wall. On the whole, ballast concrete was found to be stronger and more fireproof than gravel concrete, and from the behavior of both a general conclusion could be drawn, that the thickness of the walls must not go below a certain minimum if it is desired to prevent them from crumbling during a fire. The article gives detailed data on the bending of the walls, change of elasticity of concrete due to the heat, and the arrangement of measuring instruments for this experiment.

HOLZBANDROHREN, EIN NEUES BAUMATERIAL FÜR LUFTFAHRZEUGE. *Zeits. für Flugtechnik und Motorluftschiffahrt*, January 27, 1912. 1 p., 4 figs. *b.* Wood is not a uniform material, but consists of rings, some hard and strong, and some weak and soft. The soft rings are hygroscopic, easily affected by heat and chemical changes, and form generally the weakest part of a wood piece; it is their presence that produces the warping of wood boards. In the *Mutter system of producing wooden tubes* the hard rings are carefully split off from the piece, bent into rings, and joined together until they form a cylindrical body. Other pieces are then wound around the cylinder at an angle to the generating line, the purpose of these pieces being to take up the torsional stresses. The whole is said to form a light and extremely strong tube.

Thermodynamics

ETUDE DE LA TRANSMISSION DE LA CHALEUR ENTRE UN FLUIDE EN MOUVEMENT ET UNE SURFACE MÉTALLIQUE, Leprince-Ringuet. *Revue de mécanique*, July, September, December 1911. The author shows that the *law of exchange of heat between a gas passing through a pipe and the walls of the pipe* can be expressed by the following equation:

$$\alpha = A\ (w\omega)^n = B\ (Cw\omega)^n$$

where α is the quantity of heat transmitted per hour per square meter; w velocity of the gas in meters; ω weight of a cubic meter of gas in kilograms; n an exponent depending on the ratio of the section of passage to the perimeter of exchange. For a given fluid, C is a function of the temperature τ, and may be expressed as:

$$C = C_o\ (1 + \delta\tau)$$

The coefficient of transmission depends on the length of the tube, and it may be written

$$B = \frac{B_1}{l^p}$$

where B_1 corresponds to $l = 1$ m. In passing from one fluid to another, the coefficients B and C vary but slightly.

For air the general formula which holds good for pipes from 0.50 to 1.50 m.

(1.6 to 4.9 ft.) long, having a diameter from 0.01 to 0.10 m. (0.39 to 3.9 in.), for temperatures from 0 to 300 deg. cent. (32 to 572 deg. fahr.), may be written:

$$\alpha = \frac{51.5}{l^p}\left[0.080(1+0.0016\ \overline{\tau - 160})w_\omega\right]^n$$

or

$$\alpha = \frac{51.5}{l^p}\left[0.0595(1+0.00215\tau)w_\omega\right]^n$$

where n can be generally found from the following experimental formula:

$$n = \frac{1+18d}{1+36d} \qquad [1]$$

The author gives a $n=f(d)$ diagram containing curves from his own calculations, from formula [1], and those from the experiments of Nusselt, Jordan and Stanton. The value of p has not yet been exactly determined, but appears to be in the neighborhood of 0.13.

This formula shows that, with a dry gas, the exchange of heat can be considerably increased by increasing the quantity of gas flowing, or the perimeter of contact as compared with the section of passage, or by facilitating the production of eddies inside the pipe. The same formulæ apply to boilers, radiators, etc.

Condensation on the metal surface materially increases the exchange of heat, because the heat liberated by the condensation is set free exactly at the contact with the metal, and easily taken up by it; it is practically equivalent to making the term l^p very small or equal to zero, or multiplying the coefficient of transmission by a number from 50 to 100.

NOUVELLES RECHERCHES SUR LA DETENTE ADIABATIQUE DES GAZ ET SUR L'ÉQUIVALENT MÉCANIQUE DE LA CHALEUR, Emile Schwoerer. RAPPORT SUR LE TRAVAIL DE M. SCHWOERER, Roger Hartmann. *Bulletin de la Société industrielle de Mulhouse*, October 1911. 34 pp. *e*. New mathematical investigation of adiabatic expansion of gases and mechanical equivalent of heat.

DER WÄRMEÜBERGANG IM KREUZSTROM, Wilhelm Nuszelt. *Zeits. des Vereines deutscher Ingenieure*, December 2. The exchange of heat in a surface cooler depends on the water values of the liquids flowing through it in unit time, the temperatures of entering liquids, area of cooling surface, coefficient of heat transmission, and relative directions of the paths of the fluids. The article is devoted to the consideration of the last variable, when the two directions of flow are at right angles to each other.

If the two liquids are heated to an amount small as compared with the mean temperatures on both sides of the wall, then the total amount of heat exchanged may be taken, with sufficient approximation, as being proportional to the average difference in temperature between the two liquids. The amount of heat exchanged in unit time is then

$$Q = \frac{T_1 - t_1}{\frac{1}{KF} + \frac{1}{2W} + \frac{1}{2w}}$$

where T_1 and t_1 are the temperatures of the entering liquids, W and w water equivalents of the liquids passing through the apparatus in unit time, F area of the cooling surface, and K coefficient of heat transmission. If, however, the change of temperature of the liquid is great, the above formula has to be replaced by the equations deduced below.

Most of the surface coolers can be considered as devices consisting essentially of a rectangular cooling surface along which flow the liquids in a thin layer. The particles of each liquid may be considered to flow with equal velocities along parallel paths, while their directions of flow are at right angles to each other. In Fig. 9 the rectangle $ABCD$ represents the cooling surface. One liquid, with water equivalent per hour w, flows along the surface parallel to AB, entering along AD with a constant temperature $t=0$. The other liquid enters with a constant temperature T_0 along the side AB, and flows on the other side of the surface, parallel to AD. Let the temperature of this liquid at the point x, y, be T, that of the first liquid at the same place t. If we consider at that place a rectangular element with the sides dx and dy, then in unit time to the cooling liquid will be transferred the amount of heat

$$dQ = K dx dy (T - t)$$

The fall of temperature of the hot liquid will be equal to partial differential $\frac{\delta T}{\delta y} dy$, according to the equation $dQ = -\frac{W}{x_0}\frac{\delta T}{\delta y} dx dy$, while the rise of temperature of the cooling liquid will be $\frac{\delta t}{\delta x} dx$, corresponding to the equation $dQ = \frac{\delta t}{\delta x}\frac{w}{y_0} dx dy$.

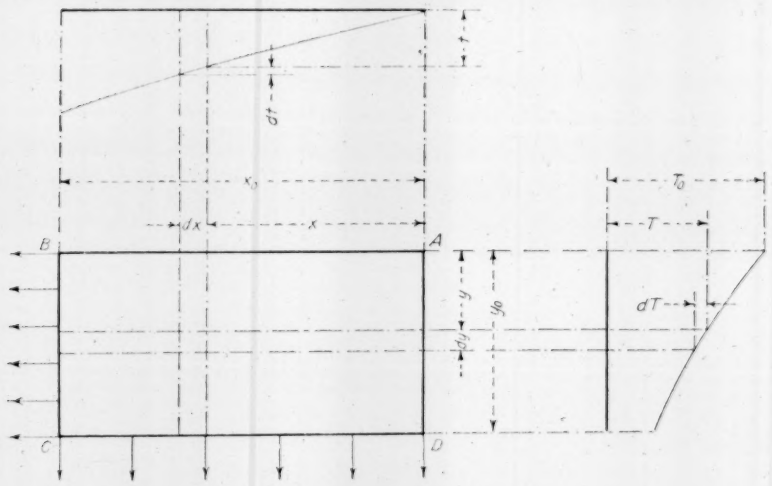

Fig. 9 Diagram of Flow of Liquids in Surface Cooler

By equating these quantities of heat to each other, we obtain the two temperatures expressed by the following partial differental equations:

$$\frac{W}{x_0}\frac{\delta T}{\delta y} = \frac{w}{y_0}\frac{\delta t}{\delta x} \quad \ldots\ldots [1]$$

$$K(T - t) = -\frac{W}{x_0}\frac{\delta T}{\delta y} \quad \ldots\ldots [2]$$

By partially differentiating the second equation in x, and substituting in the

result obtained for $\frac{\delta t}{\delta x}$ its value from the first equation, we obtain an equation containing only T

$$\frac{\delta^2 T}{\delta x \delta y} + \frac{K x_0}{W}\frac{\delta T}{\delta x} + \frac{K y_0}{w}\frac{\delta T}{\delta y} = 0 \quad \ldots\ldots [3]$$

This equation allows to calculate the path of temperatures over the surface $ABCD$, since for $y=0$, $T=T_0$, and for $x=0$, $t=0$. If we insert this value of t in equation [2], we obtain $KT = -\frac{W}{x_0}\frac{dT}{dy}$, which when integrated, gives

$$[T]_{x=0} = T_0 e^{-\frac{Kx_0}{w}y} = T_0 e^{-\frac{KFy}{Wy_0}} \quad \ldots\ldots [4]$$

When T is found, t may be obtained from equation [2] by integration. The values of T and t are as follows:

$$T - T_0 e^{-\frac{KF}{w}\frac{y}{y_0}}\left[1 + \int_0^{\frac{K^2F^2}{W w}xy} -\frac{iJ_1(2i\sqrt{z})}{\sqrt{z}} e^{-\frac{Wy_0}{KFy}z} dz\right] \quad \ldots\ldots [5]$$

$$t - \frac{T_0 e^{-\frac{KF}{W}\frac{y}{y_0}}}{\frac{KF}{W}\frac{y}{y_0}} \int_0^{\frac{K^2F^2}{Ww}xy} J_0(2i\sqrt{z})\, e^{-\frac{Wy_0}{KFy}z} dz \quad \ldots\ldots [6]$$

J_0 and J_1 are Bessel functions of zero and first order. The author gives a table of values of these functions, which can, however, be found in Jahnke und Emde: Funktionentafeln.

The amount of heat exchanged can be found either from the degree of cooling of one liquid, or from that of heating of the other. The cooled liquid leaves the apparatus along the edge $y=y_0$. Its temperature at leaving is

$$T_{y=y_0} = T_0 e^{-\frac{KF}{W}}\left[1 + \int_0^{\frac{K_2F_x^2}{W_w x_0}} e^{-\frac{W}{KFz}} - \frac{iJ_1(2i\sqrt{z})}{\sqrt{z}} dz\right] \quad \ldots\ldots [7]$$

and the amount of heat exchanged in unit time is found to be, from the mean temperature,

$$Q = W\left(T_0 - \frac{1}{x_0}\int_0^{x_0} T_{y=y_0}\, dx\right) \quad \ldots\ldots [8]$$

The amount of heat exchanged is independent of the ratio $\frac{x_0}{y_0}$ of the cooling surface, and depends only on the area of the surface.

The article contains also an example worked out by the author, and tables and curves for $y=y_0$, T, t, and $T-t$.

Miscellaneous

MATERIALPRÜFUNG IM KÖNIGL. MATERIALPRÜFUNGSAMT. *Zeits. für Dampfkessel und Maschinenbetrieb*, January 26, 1912. 4 pp. *g*. Sketch of the work done during the year 1910 by the Royal Testing Laboratory at Grosz-Lichterfelde-West. Cp. Scientific American, December 30, 1911.

WARUM VERSAGEN DIE BISHER ANGEWENDTEN BITUMINÖSEN SCHUTZHÜLLEN VON EISENROHREN, B. Haas. *Eisen-Zeitung*, December 16, 23, 1911. 2 pp. *f. Covering for gas and water pipes* consisting of jute or hemp impregnated with some bituminous substance is inferior to that in which the bituminous substance covers the pipe directly, because the jute or hemp is partly weakened by the heating of the tube previous to impregnation, and, if roughly handled, is easily broken. The bituminous covering is not stable; even if the pipes are kept long above ground, they begin to decompose and give off a certain odor. Disintegration is still more rapid when the pipe is laid in the ground, due to a large extent to the physical and chemical interaction of the iron of the pipe and the bituminous mass of the covering when hot. The author believes that a covering which could be laid on the pipe *cold* would prove preferable.

ABSTRACTS OF ARTICLES

GAS POWER SECTION

PRELIMINARY REPORT OF LITERATURE COMMITTEE

(XV)

ARTICLES IN PERIODICALS[1]

DIESEL ENGINES, LARGE RUSSIAN VESSELS PROPELLED BY, J. Rendell Wilson. *International Marine Engineering*, January 1912. 4 pp., 7 figs., 1 table.

ECONOMY OF GAS ENGINES AND STEAM TURBINES, COMPARISON OF, Franklin M. Farwell. *Electrical World*, February 3, 1912. $2\frac{1}{2}$ pp. 1 curve.

ENGINES FOR COLLIERY POWER STATIONS, GAS, J. Dunlop. *Engineering*, December 29, 1911. $\frac{2}{3}$ p. *e*.

GASLUFTHEIZUNG IN DER WERKSTATT DELITZSCH, DIE, E. Krause. *Glaser Annalen*, January 15, 1912. 12 pp., 15 figs., 3 tables, 2 curves. *A*.

Gas-air heating plant using producer gas in railroad shops at Delitzsch.

GASTURBINE, DIE, R. Oldenburg. *The Engineer* (London), January 5, 1912. $2\frac{1}{2}$ pp., 4 figs., 3 curves. *abfA*.

Extract and description of the 1000-h.p. Holzwarth gas turbine from the new book, Die Gasturbine, by Hans Holzwarth. New turbine greater than 30 per cent conversion of the primitive heat of combustion into mechanical energy at the turbine shaft.

GENERATOR FOR SMALL SIZED FUEL, THE KERPELY HIGH-PRESSURE GAS. *Stahl und Eisen*, December 28, 1911. $2\frac{1}{2}$ pp., 3 figs., 1 table. *bf*.

See erratum in Stahl und Eisen, January 18, 1912, p. 118.

INTERNAL COMBUSTION ENGINE AT SEA, THE. *Engineering*, January 12, 1912. 1 p.

Comparison of existing types of internal-combustion engines and their adaptability to this class of service.

INTERNAL-COMBUSTION ENGINES, MARINE. *The Engineer* (London), January 5, 1912. 1 p. *bdB*.

Reviews progress made in 1911 by the internal-combustion engine for propulsion of ships.

KRAFTVERSORGUNG DES KLEINGEWERBES DURCH GAS UND ELECTRIZITÄT, Hoeltje. *Dinglers Polytechnisches Journal*, January 6 and 13, 1912. 8 pp., 7 tables, 7 curves. *A*.

The power supply by gas and electricity for small shops.

[1] Opinions expressed are those of the reviewer not of the Society. Articles are classified as *a* comparative; *b* descriptive; *c* experimental; *d* historical; *e* mathematical; *f* practical. A rating is occasionally given by the reviewer, as *A*, *B*, *C*. The first installment was given in The Journal for May 1910.

MARINE GAS ENGINES: THEIR DESIGN AND APPLICATION, E. N. Percy. *International Marine Engineering*, January 1912. 3 pp.

Article continued from Vol. 16, p. 489.

MARINE OIL ENGINE, A THIRTY-DAY NON-STOP RUN OF A. *The Engineer* (London), January 26, 1912. 1 p. *bfB.*

Test of a model to prove the reliability of two 8-cylinder, 4-cycle, 2500-h.p. engines for S.S. Jutlandia.

PEAT GAS PRODUCER PLANT, A GERMAN, P. C. Percy. *Power*, January 9, 1912. $1\frac{2}{3}$ pp., 3 figs. *b.*

Description of a plant consisting of a 300-h.p. engine and Heinze peat producer at the East German Exhibition at Posen.

PEAT GAS PRODUCER PLANT IN IRELAND, A SUCCESSFUL. *Power*, January 23, 1912. $\frac{2}{3}$ p. *b.*

A Crossley installation of 400 h.p. replaces a Mond-Gas plant with a large saving in the annual fuel bill.

PETROL DRIVEN TRAMWAY CAR. *The Engineer* (London), January 19, 1912. 1 p., 2 figs. *bfC.*

Describes 55-h.p. petrol-driven cars to be used on $1\frac{1}{2}$-mile line.

POWER PLANT FOR WOOLWICH FOOTWAY TUNNEL, TEMPORARY. *The Engineer* (London), January 12, 1912. 2 pp., 2 figs. *bfA.*

Three coupled gas engines, each 150 b.h.p. and three suction producers.

PRODUCER GAS TOW BOAT. *International Marine Engineering*, January 1912. 1 fig.

General description of small tug recently designed by W. J. Deed, Jr., of Boston. Producer capacity, 100 h.p.

PUMPMASCHINEN FÜR WASSERWERKE, NEUERE, R. Schweder. *Journal für Gas und Wasserversorgung*, January 6 and 13, 1912. 17 pp., 28 figs.

Latest pumping machinery for waterworks showing gas engine driven pumps.

SEEFISCHEREI-MOTOREN, F. Romberg. *Dinglers Polytechnisches Journal*, January 6 and 13, 1912. 11 pp., 41 figs., 11 curves.

Description, construction and design of gasolene motors for fishing boats.

SUCTION GAS PRODUCER, TESTS OF A, G. M. Garland and A. P. Kratz. *Bulletin University of Illinois*, October 16, 1911. 88 pp., 6 figs., 4 tables, 27 curves.

TURBINE, THE HOLZWARTH GAS. *Power*, February 6, 1912. 5 pp., 8 figs., 3 curves. *bc.*

A new type of gas turbine in which the fuel is intermittently burned in the combustion chamber and between times the chamber is cleaned by scavenging with a cooling medium.

GENERAL NOTES

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

The annual meeting of the American Society of Heating and Ventilating Engineers was held at the Engineering Societies Building in New York, January 23 to 25. In addition to the address of President R. P. Bolton, Mem. Am. Soc. M. E., on The Use and Abuse of Fuel, papers were presented as follows: Drying Apparatus, H. C. Russell and A Heat Exchange Diagram, N. W. Akimoff; Dust in Relation to Heating, Konrad Meier, Mem. Am. Soc. M.E.; Effect of Relative Humidity on Comfort and Health, J. I. Lyle, Mem. Am. Soc. M. E.; Chemical Notes on Ventilation, P. N. Evans; Ventilation Problems, D. D. Kimball; Steam Heating Large Department Stores, Davis S. Boyden; Hot Water Heating by Forced Circulation, Ira N. Evans; Auxiliaries for Pressure Systems of Hot Water Heating, J. J. Wilson; Steam Heating from the Receiver of the Compound Engine, Auguste Beaurrienne; Ventilating a Steam Laundry, A. M. Feldman, Mem. Am. Soc. M. E.; Heat Transmission with Indirect Radiation, Frank L. Busey; Tests of Vacuum Cleaning Tools and Exhausters, M. S. Cooley; Definition of the Unit of Heat, R. P. Bolton, Mem. Am. Soc. M. E.; Heating a Swimming Pool, Cesar Teran. Frank T. Chapman, Mem. Am. Soc. M. E., presented an informal paper on the ventilation, or rather the lack of ventilation of motion-picture theaters. Wm. Kent, Mem. Am. Soc. M. E., presented a special committee report on standards for pipe fittings and flanges.

Officers for the ensuing year were elected as follows: President, John R. Allen, Mem. Am. Soc. M. E.; Vice-Presidents, John F. Hale and E. F. Capron; Secretary, W. M. Macon, Jun. Mem. Am. Soc. M. E.; Treasurer, James A. Donnelly, Mem. Am. Soc. M. E. The following were elected to the Board of Governors, R. P. Bolton, Mem. Am. Soc. M. E.; James D. Hoffman, Mem. Am. Soc. M. E., F. R. Lewis, W. M. MacKay, D. D. Kimball.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS

The annual meeting of the Illinois Society of Engineers and Surveyors for 1912 was held at the University of Illinois, Urbana, Ill., on January 17, 18 and 19, and the program was of unusual excellence. The more important engineering topics discussed were stream pollution, sewage disposal, accuracy in surveying, road and pavement problems, and the bridge work of the Illinois Highway Commission. Two illustrated lectures of great interest were given, one by I. O. Baker on the Panama Canal, and one by H. L. Cooper on The Keokuk Water Power Plant. An afternoon was spent in inspecting the buildings and discussing the work of the College of Engineering.

AMERICAN INSTITUTE OF MINING ENGINEERS

The annual meeting of the American Institute of Mining Engineers was held February 19–21, 1912, at the Engineering Societies Building, New York. An in-

formal social meeting was held on the evening of February 19, after which Charles Kirchhoff, Mem. Am. Soc. M. E., retiring president of the institute, gave an address on Institute Aims and Ideals. An informal smoker followed. Papers presented at the various professional sessions were in part as follows: Agglomeration of Fine Materials, W. S. Landis; Temperature Conversion-Tables, Leonard Waldo, Mem. Am. Soc. M. E.; Abrasion and Dust-Losses in Ore-Drying, C. F. Dietz, Mem. Am. Soc. M. E. and D. V. Keedy; Mine-Lamps, David B. Rushmore, Mem. Am. Soc. M. E.; Progress in Roll-Crushing, N. V. Hansell; A Concise Method of Showing Ore-Reserves, N. H. Emmons; Electrolytic Refining of Impure Copper, H. H. Emrich; Fuel Economy of Blast; The Smokeless Dry Coal Field of West Virginia, E. Ludlow.

IOWA ENGINEERING SOCIETY

The annual meeting of the Iowa Engineering Society was held February 21-23, 1912, at Davenport, Iowa. Among the papers presented were: Concrete roadways, J. H. Chubb, and Concrete Pavements with Bituminous Top Coat, N. H. Tunnicliff. The following reports were also made: Railroad Engineering, S. N. Williams; Sanitary Engineering, A. Marston; Minimum Highway Bridge Specifications, J. B. Marsh; Roads and Pavements, T. H. MacDonald; Legislation, Paul Beer. An inspection trip to the hydroelectric plant of the Mississippi River Power Company at Keokuk was enjoyed by the members in attendance.

KANSAS ENGINEERING SOCIETY

The annual meeting of the Kansas Engineering Society was held January 23 and 24, 1912, at Manhattan, Kan. The papers were as follows: How Roads Should be Classified and how the Different Classes Should be Constructed and Maintained, W. S. Gearhart, H. A. Rowland, C. C. Huntington, F. R. Hesser and E. E. Clark; Field Methods, Office Practice and Supervision and Inspection of Paving Work in Topeka, A. R. Young, E. G. Gibson and C. A. Foster; Work of the Engineering Department of the Public Utilities Commission, C. C. Witt; The Management of City Utilities and Their Valuation, C. S. Burns; The Velocity of the Flow of the Kansas River, V. R. Parkhurst; The Contamination of City Wells, S. C. Loper; The Use and Abuse of Sewage Disposal Plants, C. A. Smith.

PERSONALS

John F. Allison has resigned from Clemson Agricultural College, Clemson College, S. C., as instructor in forge and foundry, to accept a position as instructor in mechanical engineering and shopwork at Maryland Agricultural College, College Park, Md.

Fred. W. Ballard has been appointed engineer of construction of the new electric lighting plant of the City of Cleveland, O. Mr. Ballard has been serving as the manager of the engineering and construction department of the Sherwin-Williams Co., Cleveland, O.

Frederick W. Cox has assumed the duties of general salesman of Shewan Tomes & Co., Hongkong, China.

Charles H. Craig, Jr., formerly with Chas. T. Main of Boston, Mass., has become associated with Edward H. McClintock, under the firm name of McClintock & Craig, engineers and architects, with offices in Springfield, Mass.

W. G. Diman has accepted a position with the Amoskeag Manufacturing Co., Manchester, N. H., in the capacity of supervising engineer.

L. L. Griffiths has resigned his position of general superintendent of the Texas Portland Cement Co., and opened an office in Dallas, Tex., as president of the L. L. Griffiths Engineering Co., consulting civil, mechanical and electrical engineers. Mr. Griffiths is retained by the Texas Portland Cement Co. as consulting engineer.

F. A. Haughton has accepted a position with the Remington Arms and Ammunition Co., Ilion, N. Y., in the capacity of works manager. He was recently general superintendent of the Taylor Iron and Steel Co., High Bridge, N. J.

George J. Henry, Jr. has resigned as chief engineer and sales manager of the Pelton Water Wheel Co., San Francisco, Cal., to open an engineering office in the same city.

O. Z. Howard has accepted a position with the Griscom-Spencer Co., New York. He was formerly associated with the U. S. Naval Engineering Experiment Station, Annapolis, Md.

Harry M. Latham has assumed the duties of manager of the steam and electrical departments of B. F. Sturtevant Co., Hyde Park, Mass. He was until recently associated with the American Steel and Wire Co., Worcester, Mass.

Leo Loeb, formerly identified with the Cambria Steel Co., Johnstown, Pa., in the capacity of assistant steam engineer, has entered the service of the Naval Experiment Station, Annapolis, Md.

V. M. Palmer has assumed the duties of standardizing engineer with the

U. S. Motor Co., New York. He was formerly factory manager and chief engineer of the B. F. Board Motor Truck Co., Alexandria, Va.

H. W. Peck has been appointed vice-president and general manager of the Schenectady Illuminating Co., Schenectady, N. Y. Mr. Peck was until recently associated with the Rochester Railway and Light Co., Rochester, N. Y., as assistant to general manager.

George B. Pickop has assumed the duties of general superintendent of the Universal Machine Screw Co., Hartford, Conn. He was formerly master mechanic with P. & F. Corbin, New Britain, Conn.

E. Posselt has opened an office as consulting mechanical and industrial engineer, in Denver, Colo. He was connected with the Colorado Portland Cement Co. as engineer in charge of construction, and since January 1912, has been retained as consulting engineer for the Cement Securities Co., Denver, Colo.

E. P. Roberts has been appointed smoke inspector of Cleveland, O.

P. F. Smith, Jr. has been appointed superintendent of motive power of the Pennsylvania Lines, Toledo, O. He was formerly master mechanic of the Pennsylvania Railroad Shops, Columbus, O.

Robert I. Todd, who has acted as general manager of the Indianapolis Traction and Terminal Co., was elected president of the company, to succeed the late Hugh J. McGowan. Mr. Todd likewise succeeds Mr. McGowan as president of the Terre Haute, Indianapolis and Eastern Traction Co., one of the longest lines in the State.

C. R. Whittier has become associated with the General Chemical Co., New York. He was formerly connected with the Standard Plunger Elevator Co., New York.

EMPLOYMENT BULLETIN

The Society considers it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is most anxious to receive requests both for positions and for men available. Notices are not repeated except upon special request. Copy for the Bulletin must be in hand before the 12th of the month. The list of men available is made up of members of the Society, and these are on file in the Society office, together with names of other good men not members of the Society, who are capable of filling responsible positions. Information will be sent upon application.

POSITIONS AVAILABLE

0144 Young man for office to take charge of sales department of triplex pump business. Location Middle West. Apply through Am. Soc. M. E.

0145 Designer on automobile work, one preferred who has had experience in gear case design, knowledge of high speed transmission and worm gearing. Good mathematician with knowledge of strength of materials. New York.

0146 Young technical graduate, good draftsman, capable of taking hold of mechanical heat and power tests for purpose of securing data for the modification or improvement of existing apparatus. Location Colorado.

0147 Man to take charge of gear cutting department. Position will pay from $1800 to $3000 to right party, depending on the ability of the man who can take the department and show results of uniform quality and quantity; must be thoroughly up in theory and practice on bevel and spur gears and have a record as a producer. Location Middle West.

0148 Large stationary gas engine manufacturers in England, desire man thoroughly familiar with systematization of large enterprises to take up work of reorganization of their plant. Apply through Am. Soc. M. E.

0149 Prominent maker of air compressors is in need of three experienced and efficient salesmen. State details of previous experience, references and compensation expected. Answer in handwriting. Address care of Am. Soc. M. E.

0150 Young man with technical knowledge and shop experience, as assistant foreman of concern manufacturing pressure reducing and regulating valves and other specialties. Position offers good opportunities for advancement to a young man with ambition.

MEN AVAILABLE

369 Manager, technically trained with 15 years' experience in shop designing, engineering sales and management, desires to change for position in business, sales or executive end of manufacturing concern. Capable of manufacturing executive work or of managing manufacturers agency proposition.

370 Mechanical engineer, 14 years' experience in engineering and buying, desires to represent reliable eastern firm in San Francisco. Either sales or engineering work.

371 Master mechanic or superintendent of power, desires position. Can produce results. Familiar with large steam or gas power plants; would accept position with mechanical engineer to make tests on power propositions. Thirty-nine years of age, married. Can furnish best of references.

372 Technical graduate of seven years' standing with both technical and business experience, desires to purchase interest in paying manufacturing business, which desires to increase capital and where technical knowledge will be useful.

373 Member, mechanical engineer, power plant and mill engineering, heating, ventilating, extensive experience in design, office work and field work. Best of references. Desires executive position.

374 Mechanical and construction engineer, technical education, 12 years' broad practical experience, desires responsible position in manufacturing or engineering lines. Forceful and energetic, executive and business ability, systematic and direct; understands values and economies of production, originality and inventive ability. Capable of responsible charge of manufacturing department.

375 Technical graduate, experienced in laying out and installing industrial plants and electric installations; married; age 32. Desires position as manager or superintendent of small growing factory; practical experience in machine shop and drafting room, devising and installing complete cost, shop and production systems, factory executive in responsible charge.

376 Junior; technical graduate, age 28, married, eight years' experience; designing, estimating costs, inspecting, with company manufacturing railroad cars and contractor's equipment; assistant engineer on power and industrial plant design; heating and ventilating; selling; at present employed. Desires position with engineer, contractor or manufacturer as assistant, branch manager or sales engineer.

377 Associate; technical education; 12 years' experience, familiar with latest manufacturing methods; desires position as master mechanic or efficiency engineer, requiring extensive knowledge of the shop.

378 Stevens graduate, married; varied experience with representative concerns in lines of manufacture and mechanical engineering, at present connected with large manufacturing concern, working in lines of reorganization and improvements of methods including planning, standardization of operations, classification, rearrangement, cataloging, symbolizing stock, ready to take up work in similar lines. Leaving present employer with full consent.

379 Member, technical graduate, long experience as testing engineer, chief engineer, superintendent and consulting mechanical engineer with extensive experience in steam and electric power companies, textile, rubber and other industrial corporations. Special experience in reducing operating costs in indus-

trial power plants, management of mechanical and operating departments. Desires position as executive mechanical engineer or superintendent with large industrial or power company.

380 Young engineer, with literary and editorial experience, imagination, executive ability and knowledge of men desires position in active engineering work. Previous experience in design, systematizing, assistant engineer.

ACCESSIONS TO THE LIBRARY

With Comments by the Librarian

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A. I. E. E. and A. I. M. E. can be secured on request from Calvin W. Rice, Secretary Am. Soc. M. E.

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GAZOGÈNES ET MOTEURS À GAZ PAUVRE À LA PORTÉE DE TOUS, René Champly. *Paris, 1911.*

HARDENING AND TEMPERING STEEL, B. E. Jones. *London-New York, 1911.*

HEAT TREATMENT OF TOOL STEEL, Harry Brearley. *New York, Longmans, Green & Co., 1911.*

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KINEMATICS OF MACHINES, R. J. Durley. ed. 2. *New York, 1911.*

LEADING AMERICAN MEN OF SCIENCE, D. S. Jordan. *New York, 1910.*

LEAGUE OF IMPROVEMENT SOCIETIES IN RHODE ISLAND. Year Book, 1911-1912. Gift of Brown & Sharpe Mfg. Co.

MANUFACTURE OF SULPHATE OF AMMONIA, G. T. Calvert. *London, 1911.*

LE MATÉRIEL DES CHEMINS DE FER, J. B. Flamme. *Paris, 1911.*

MECHANISM OF WEAVING, T. W. Fox. *London, 1911.*

MODERN METHODS OF SEWAGE PURIFICATION, G. B. Kershaw. *London, 1911.*

MONTHLY OFFICIAL RAILWAY LIST, January 1912. Gift of Railway List Company.

MUNICIPAL JOURNAL AND ENGINEER, vols. 14-19. *New York, 1903-1905.*

PANAMA CANAL. Notes and views taken by members of the American Society of Civil Engineers during their visit, March 1911. *Boston, 1911.* Gift of G. A. Kimball.

PHYSICO-CHEMICAL TABLES FOR THE USE OF ANALYSTS, PHYSICISTS, CHEMICAL MANUFACTURERS AND SCIENTIFIC CHEMISTS, J. C. Evans. Vols. 1-2. *London, 1902, 1911.*

PROTECTION OF NEW YORK'S WATER SUPPLY FROM POLLUTION DURING CONSTRUCTION WORK, A. J. Provost, Jr. Reprinted from Journal of New England Water Works Association, vol. 25, no. 3. Gift of Messrs. Lederle and Provost.

RHODE ISLAND TRACTION IMPROVEMENT AND DEVELOPMENT. Report of the Joint Committee on Railroad Franchises, June 1911, B. J. Arnold. *Providence, 1911.* Gift of the author.

SEWERAGE SYSTEMS, THEIR DESIGN AND CONSTRUCTION, H. S. Watson, with Legal Notes by E. B. Herbert. *London, 1911.*

SHORT COURSE IN GRAPHIC STATICS FOR STUDENTS OF MECHANICAL ENGINEERING, W. L. Cathcart and J. I. Chaffee. *New York, Van Nostrand Co., 1911.*

This is an abridgement of the authors' larger book, Elements of Graphic Statics. Its purpose is to provide students of mechanical engineering with a brief course of graphic statics which will serve when the time to be devoted to the subject is short. The treatment has been restricted mainly to the properties and general uses of the

force and equilibrium polygons. Some attention has been given to the design of trusses.

STEAM ENGINE AND TURBINE. A TEXT-BOOK FOR ENGINEERING COLLEGES. R. C. Heck. *New York, Van Nostrand Co., 1911.*

Partly adapted from the writer's Steam Engine and Other Steam Motors, but largely rewritten. The furnace and boiler and their accessories are not considered, except to make frequent reference to their functions. The book has an extremely adequate index.

SULLA TEORIA ANALITICA DELLE ELICHE E SU ALCUNI METODI SPERIMENTALI, G. A. Crocco. (Rendiconti degli Studi ed Esperienze, vol. 1, no. 1). *Roma, 1911.*

TECHNOLOGY OF BREAD MAKING, William Jago and W. C. Jago. *London, 1911.*

TEXT-BOOK ON GAS, OIL AND AIR ENGINES, Bryan Donkin. ed. 5. *London, 1911.*

THOMAS' REGISTER AND FIRST HANDS IN ALL LINES. ed. 5, 1912. *New York, 1912.*

TRAITÉ PRATIQUE DE LA POSE ET L'ENTRETIEN DES CANALISATIONS DE GAZ, F. Barbe. *Paris, 1910.*

TRANSPORTATION BY RAIL; An Analysis of the Maintenance and Operation of Railroads, T. M. R. Talcott. *Richmond, 1904.*

WATER WORKS EFFICIENCY 1. WATER WASTES SURVEY. Bull. No. 11, Milwaukee Bureau of Economy and Efficiency. *Milwaukee, 1911.*

WELTADRESSBUCH DER CHEMISCHEN INDUSTRIE, 1911. *Berlin, 1911.*

WHITAKER'S ALMANAC, 1912. *London, 1912.*

GIFT OF JOHN CALDER

AMERICAN LABOR LEGISLATION REVIEW. Vol. 1, no. 4, December, 1911.

CITY CLUB BULLETIN. Vol. 5, no. 6, January 24, 1912.

LABOR LAW IMPROVEMENT AND ENFORCEMENT: The Manufacturer's Attitude, John Calder. Reprinted from publications of the Academy of Political Science, vol. 2, no. 2. *New York, 1911.*

NATIONAL CIVIC FEDERATION. Proc. Department on Compensation for Industrial Accidents and Their Prevention, December 8, 1911.

SURVEY. Vol. 27, no. 16, January 20, 1912.

EXCHANGES

AMERICAN SOCIETY OF CIVIL ENGINEERS. Trans., vol. 69, 1910. *New York, 1910.*

INSTITUTION OF AUTOMOBILE ENGINEERS. Proc., vol. 5. *Westminster, 1911*

MASTER CAR BUILDERS' ASSOCIATION. Report of the Proceedings, vol. 45. *Chicago, 1911.*

SMITHSONIAN INSTITUTION. Annual Report, 1910. *Washington, 1911.*

UNITED ENGINEERING SOCIETY

GESCHAFTS-BERICHT DER DEUTSCHEN BUCHDRUCKER BERUFS-GENOSSENSCHAFT ÜBER DAS RECHNUNGSJAHR, 1910. *Frankfurt-am-Main.*

VIRGINIA STATE CORPORATION COMMISSION. Annual Report, 8th, 1910. *Richmond, 1911.*

———Appendix to Annual Report, 8th, 1910. *Richmond, 1911.* Gift of T. C. Martin.

IOWA RAILROAD COMMISSIONERS. Annual Report, 33d, 1910. *Des Moines, 1910.* Gift of American Electric Railway Association.

WISCONSIN RAILROAD COMMISSION. Opinions and Decisions, vol. 4. *Madison, 1910.* Gift of American Electric Railway Association.

TRADE CATALOGUES

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS, *Philadelphia, Pa.* Factories and warehouses built of reinforced concrete, 223 pp.

BEST MANUFACTURING CO., *Pittsburgh, Pa.* Catalogue and handbook of piping material, for steam, air, hydraulic work and high and low pressure, 396 pp.

HENDEE MFG. CO., *Springfield, Mass.* Indian motorcycles for 1912, 24 pp.

HESS-BRIGHT MFG. CO., *Philadelphia, Pa:* Data sheet on worm mounting; worm and worm-gear mounting; bearing mountings, without shoulders on shafts; change gear case typical mounting, 9 sheets.

CHAS. E. MILLER, *New York.* Motorcars; motorboats; motorcycles; motorplanes and accessories, 114 pp.

TOLEDO ELECTRIC WELDER CO., *Cincinnati, O.* Bull. No. 11, Butt welding machines, 35 pp.

VEEDER MFG. CO., *Hartford, Conn.* Veeder products including mileage recorders, tachometers, telephone counters, etc., 84 pp.

UNITED ENGINEERING SOCIETY

SIMPLEX CONSTRUCTION CO., *New York.* Simplex system of concrete piling, 96 pp.

CHANGES IN MEMBERSHIP

CHANGES IN ADDRESS

ALLISON, John Franklin (Junior, 1910), Instr. Mech. Engrg. and Shop work, Md. Agri. College, College Park, Md., and 33 Q St., N. E., Washington, D. C.

BARRON, Claude M. (Junior, 1910), Cons. Engr., R. W. Cameron & Co., 23 S. William St., New York, N. Y., and 2009 Forest Ave., St. Louis, Mo.

BAYLIS, Arthur Raymond (1905; 1906), Ewing, Bacon & Henry, 30 Church St. New York, and *for mail*, 1815 Ave. K, Flatbush, Brooklyn, N. Y.

BIBBINS, James Rowland (1904; 1909), Engr. with Bion J. Arnold, 105 S. La Salle St., Chicago, Ill., and *for mail*, 1310 Hewes Bldg., San Francisco, Cal.

BILLINGS, A. W. K. (1909), Barcelona Traction, Light & Power Co., Apartado 491, Barcelona, Spain.

BLOOD, John Balch (1895; 1903), Cons. Engr., 10 P. O. Sq., Boston, and *for mail*, 232 High St., Newburyport, Mass.

BROWN, John Quincy (1906), Ch. Engr. Mech. and Elec. Dept., Oakland Traction Co., and San Francisco, Oakland & San Jose Ry., Oakland, Cal.

BUFFUM, F. D. (1902; Associate, 1904), Ellsworth, Washington Co., Pa.

CHAMBERLAIN, Harry M. (1907), Macker-Tyler Co., 31 Central St., Worcester, and *for mail*, 17 Wrentham St., Dorchester Centre, Mass.

CHILDS, Eugene (1899), Rep., Gath Mch. Tool Co., 61 Terrace, Buffalo, N. Y., and *for mail*, 410 E. 6th St., Erie, Pa.

COX, Frederick W. (1908), Genl. Salesman, Shewan Tomes & Co., Hongkong, China.

CRAIG, Charles H., Jr. (1908), Member of Firm, McClintock & Craig, 33 Lyman St., Springfield, Mass.

DAM, William Valdemar (1906), Genl. Mgr., Thompson & Co., and *for mail*, "Kalimna," Hall St., Castlemaine, Victoria, Australia.

DAVIS, William J., Jr. (1910), Pacific Coast Engr., Genl. Elec. Co., 720 Rialto Bldg., San Francisco, Cal., also Ch. Engr., Mexican No. Power Co., Montreal, Canada.

DIMAN, Walter G. (1909), Supv. Engr., Amoskeag Mfg. Co., Manchester, N. H.

DU BARRY, Ed. G. (Junior, 1910), Minneapolis Steel & Mchy. Co., and *for mail*, 2604 Aldrich Ave., S., Minneapolis, Minn.

DUNLAP, George W. (1911), Pub. Service Com., 1828 Tribune Bldg., New York, N. Y.

FLINN, Charles Forrest (Associate, 1905), Supt., L. E. White Lumber Co., Balboa Bldg., San Francisco, and Elk, Mendocino Co., Cal.

FREDERICK, Floyd W. (1907), Prof. Mech. Engrg., Howard Univ., and *for mail*, 607 Taylor St., N. W., Washington, D. C.

GERRISH, William H. (1901), Ch. Smoke Inspr., Bd. of Gas and Elec. Light Commrs., Commonwealth of Mass., 603 Ford Bldg., 15 Ashburton Pl., Boston, and *for mail*, 173 Main St., Malden, Mass.

HAUGHTON, Frank A. (1903), Wks. Mgr., Remington Arms & Ammunition Co., Ilion, N. Y.

HOUSKEEPER, Wm. G. (Junior, 1906), Engr., Westinghouse Lamp Co., Bloomfield, N. J., and *for mail*, 3508 Baring St., Philadelphia, Pa.

HOWARD, O. Zell (1908), The Griscom Spencer Co., 90 West St., New York, N. Y.

JONES, Benjamin N. (1904), Mgr. of Mfg., Otis Elevator Co., New York, N. Y., and *for mail*, 296 Essex Ave., Orange, N. J.

KEITH, Thomas M. (1905; 1910), 241 Clifton Pl., Brooklyn, N. Y.

LEAMAN, Charles Henry (Junior, 1910), 1242 Perkiomen Ave., Reading, Pa.

LEE, Ralph A. (Junior, 1909), Engr. Mfg. Dept., Barrett Mfg. Co., 17 Battery Pl., New York, and *for mail*, 578 75th St., Brooklyn, N. Y.

LEIGHTON, Edward I. (1892), St. Augustine, Fla., and 1183 East Blvd., Cleveland, O.

LEITCH, Meredith (1898), Mech. Engr., De Laval Separator Co., Poughkeepsie, N. Y.

LOEB, Leo (Junior, 1911), Mech. Engr., Naval Exper. Sta., Annapolis, Md.

LOWE, Henry Leland (Junior, 1903), Genl. Motors Co., and *for mail*, 544 Field Ave., Detroit, Mich.

McMULLIN, Frank V. (1903), Treas., Pa. Forge Co., Philadelphia, Pa.

MAHL, F. W., (1892; 1910), Union Pacific System So. Pacific Co., 165 Broadway, New York, and *for mail*, 20 Primrose Ave., Mt. Vernon, N. Y.

MERRILL, Albert S. (Junior, 1903), 125 N. 3d St., Easton, Pa.

MERRILL, Joseph J. (1911), Ch. Engr., Corn Products Refining Co., 29 E. Madison St., and 229 S. Central Park Ave., Chicago, Ill.

MOXHAM, Egbert (Junior, 1906), Asst. Mgr. Development Dept., E. I. du Pont de Nemours Co., and *for mail*, 1101 Rodney St., Wilmington, Del.

NETTLETON, William Alpheus (1905), 1625 Prairie Ave., Chicago, Ill.

NORRIS, William H., Jr. (Junior, 1909), Engr., 3622 Chestnut St., Philadelphia, Pa.

OLIVER, E. C. (Junior, 1902), Factory Mgr., Renfro Speedometer Co., 302 Palmer Bldg., 70 Washington Blvd., Detroit, Mich.

PARISH, Wm. H. (Junior, 1905), Commer. Engr., Westmoreland Coal Co., 224 S. 3d St., Philadelphia, and 128 Tulpehocken St., Germantown, Philadelphia, Pa.

PEARSON, Walter Ambrose (1907), 135 Front St., New York, N. Y.

PECK, Henry W. (Associate, 1908), V. P. and Genl. Mgr., Schenectady Ill. Co., Schenectady, N. Y.

PICKOP, George B. (1908), Genl. Supt., Universal Mch. Screw Co., 806 Windsor St., Hartford, Conn.

POSSELT, Ejnar (Junior, 1907), Cons. Mech. and Industrial Engr., 511 Ideal Bldg., Denver, Colo.

PRATT, Charles Richardson (1896), Cons. Engr., 39 Gates Ave., Montclair, N. J.

PRICE, Norman I. (Junior, 1902), Price & Martyn, 68½ Pitt St., Sydney, N. S. W., Australia.

QUICK, Ray Lewis (Junior, 1911), Pratt & Whitney Co., 111 Broadway, New York, and *for mail*, 166 Remsen St., Brooklyn, N. Y.

QUIMBY, William E. (1889; 1905), Pres., William E. Quimby, Inc., 548 W. 23d St., New York, N. Y., and Llewellyn Park, Orange, N. J.

ROGERS, John I. (Junior, 1910), Cons. Engr., 929 Chestnut St., Philadelphia, and Wyncote, Pa.

ROWLEY, Harry Wm. (1896), 2138 California St., Washington, D. C.

ROWLEY, Ridgway Lloyd (Junior, 1910), Inspc. Engr., Bd. of Fire Underwriters of the Pacific, 914 Merchants Exch., San Francisco, and 398 60th St., Oakland, Cal.

ROYSE, Daniel (1891; 1904), Asst. to Dir. of Purchases, Union Pacific R. R., 165 Broadway, New York, N. Y.

ST. CLAIR, James Thorpe (Junior, 1901), Pres., Wesley Mfg. Co., 314 S. 8th St., St. Louis, Mo.

SAR VANT, Wilbur Nason (Junior, 1907), 16 Verona Pl., Brooklyn, N. Y.

SCOTT, Walter G. (Junior, 1909), Fenton, Mich.

STRAUSS, Julian B. (1910), care of Martin Strauss, Schumanstr. 29, Frankfort, Germany.

THOMPSON, Albert W. (1900;1907), Supt., Lowell Mch. Shop, and Fairmount St., Lowell, Mass.

VALENTINE, Warren P. (Junior, 1904), Engrg. Dept. and Charge of Mech. Drawing Dept., Trades Apprentice Sch. of Westinghouse Elec. & Mfg. Co., East Pittsburgh, and *for mail*, 204 West St., Wilkinsburg, Pa.

WALLIS, James T. (1901), Genl. Supt. M. P., Pa. R. R., Lines East of Pittsburgh, Altoona, Pa.

WELLS, J. Barnard (Junior, 1909), 44 Oakvale Ave., Berkeley, Cal.

WHEELER, Frank R. (1909), Member of Firm, Guernsey & Wheeler, 436 Rialto Bldg., San Francisco, and 700 Central Bldg., Los Angeles, Cal.

WHITTIER, Chas. Robert (1909), Genl. Chem. Co., 25 Broad St., and *for mail*, 204 W. 111th St., New York, N. Y.

WILE, Julius I. (1904; 1908), Chalmers & Williams, Chicago Heights, Ill.

WILLIAMS, Alan Gillespie (Junior, 1909), Eng. House Foreman, Vandalia R. R., and *for mail*, 447 N. 7th St., Terre Haute, Ind.

WILLIAMS, Charles Henry (1901; 1904), Genl. Mgr., The No. Colo. Power Co., 1008 Gas and Elec. Bldg., Denver, Colo.

WISEWELL, Francis H., Jr. (Junior, 1905), V. P., Mohawk Valley Htg. Co., 22 Broad St., and *for mail*, The Olbiston, Genesee St., Utica, N. Y.

WUERFEL, Geo. D. (1908), Member of Firm, Wuerfel & Miggett, 1125 Ohio Bldg., and *for mail*, 823 Erie St., Toledo, O.

WYATT, Edgar William (1910), The M. Werk Co., Poplar St., Cincinnati, O.

YOUNG, Gilbert A. (1906), Acting Prof. Mech. Engrg., Purdue Univ., and *for mail*, 725 Highland Ave., Lafayette, Ind.

NEW MEMBERS

BRAUN, Horace Herbert (Junior, 1911), Mech. Engr., U. S. Smelting, Refining & Min. Co., Las Cajas, Pachuca, Hidalgo, Mex.

CLARK, Charles Ethan (1911), Mfg. Saw Mill Mchy., Steam and Gas Engs., 406 N. Main St., Wellsville, N. Y.

DU PRIEST, John Randolph (1911), 921 E. State St., Ithaca, N. Y.

ELROD, H. E. (1911), Genl. Mgr., Union Iron Wks., and *for mail*, 1909 Crawford St., Houston, Tex.

HOPKINSON, Allen Haigh (1911), Gov. Dir., J. Hopkinson & Co., Ltd., Britannia Wks., Huddersfield, England.

JONES, John Lucien (Junior, 1911), Asst. Prof. Mech. Engrg., Okla. Agri. and Mech. College, Stillwater, Okla.

LINDQUIST, Eric Adolf (Junior, 1911), Middletown, Conn.

McNEILL, Joseph Hensley (1911), Ch. Inspr., Boiler Inspc. Dept., and Chairman Bd. of Boiler Rules, Commonwealth of Mass., State House, Boston, Mass.

MAUGER, David Napier (Junior, 1911), Draftsman and Estimator Engrg. Dept., Babcock & Wilcox Co., Bayonne, and *for mail*, 705 W. 7th St., Plainfield, N. J.

MOONEY, Franklin Proctor (Junior, 1911), Ch. Electrician, The Arrowhead Reservoir & Power Co., San Bernardino, Cal.

PAWLETT, Louis M. (Junior, 1911), Exec. Engr., Locomobile Co. of Am., and *for mail*, 231 Fairfield Ave., Bridgeport, Conn.

POTTER, Philip Arthur (1911), Hyd. Cons. Engr. with Nicholas S. Hill, Jr., 100 William St., and *for mail*, 315 W. 97th St., New York, N. Y.

REARDON, Patrick H. (Associate, 1911), Pres. and Genl. Mgr., The Compressed Air Mchy. Co., 39-51 Stevenson St., San Francisco, Cal.

ROCKWOOD, George O. (1911), Pres., The Rockwood Mfg. Co., P. O. Box 636, Indianapolis, Ind.

ROTE, John G. (Junior, 1911), Gillette Safety Razor Co., and *for mail*, 84 Prescott St., Cambridge, Mass.

STOUGHTON, Bradley (1911), Cons. Engr., 165 Broadway, New York, N. Y.

THOMSON, John Edgar (Junior, 1911), Engr. and Designer, John Thomson Press Co., 253 Broadway, New York, N. Y.

WATKINS, Frank Elias (1911), Asst. Mgr., Power & Min. Mchy. Co., Internatl. Gas Eng. Co., Cudahy, and *for mail*, 545 Superior St., Milwaukee, Wis.

WOODMANSEE, Fay (1911), Cons. Engr., Woodmansee, Davidson & Sessions, 1048 First Natl. Bank Bldg., Chicago, Ill.

PROMOTIONS

DORNER, Frederick Harry (1907; 1911), Mech. Engr., Bayley Mfg. Co. and *for mail*, 716 Prospect Ave., Milwaukee, Wis.

DEATHS

BUCK, W. F., January 31, 1912.

SANCTON, Edward K., December 26, 1911.

STILLMAN, Francis H., February 18, 1912.

COMING MEETINGS

MARCH-APRIL

Advance notices of annual and semi-annual meetings of engineering societies are regularly published under this heading, and secretaries or members of societies whose meetings are of interest to engineers are invited to send such notices for publication. They should be in the editor's hands by the 15th of the month preceding the meeting. When the titles of papers read at monthly meetings are furnished they will also be published.

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS
March 17, annual meeting, Chicago, Ill. Secy., O. G. Fetter, Carew Bldg., Cincinnati, Ohio.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION
March 12-15, annual convention, New Orleans, La. Secy., J. D. Farasey, E. 37th St. and Erie R. R., Cleveland, O.

AMERICAN RAILWAY ENGINEERING ASSOCIATION
March 19-21, annual convention, Chicago, Ill. Secy., E. H. Fritch, Monadnock Blk.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
April 8, monthly meeting, 29 W. 39th St., New York. Secy., F. L. Hutchinson.

AMERICAN SOCIETY OF CIVIL ENGINEERS
March 6, 20, bi-monthly meetings, 220 W. 57th St., New York. Secy., C. W. Hunt.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
Monthly Meetings: New York, March 12; Boston, March 15; Philadelphia, March 7. Secy., Calvin W. Rice, 29 W. 39th St.

CANADIAN FREIGHT ASSOCIATION
April 11, annual meeting, Montreal, Que. Secy., T. Marshall, Toronto, Ont.

CANADIAN MINING INSTITUTE
March 6, annual meeting, Ottawa, Can. Secy., H. Mortimer-Lamb, Windsor Hotel, Montreal.

MISSOURI HIGHWAY ENGINEERS' ASSOCIATION
March 14-21, annual convention, Kansas City, Mo.

NATIONAL ASSOCIATION OF CEMENT USERS
March 11-16, annual convention, Kansas City, Mo. Secy., Edward E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL ASSOCIATION OF COTTON MANUFACTURERS
April 24-25, annual meeting, Charitable Mechanics Bldg., Boston, Mass. Secy., C. J. H. Woodbury, 45 Milk St.

NATIONAL BRICK MANUFACTURERS ASSOCIATION

March 6-9, annual convention, Chicago, Ill. Secy., T. A. Randall, Indianapolis, Ind.

NATIONAL CIVIC FEDERATION

March 5-7, annual meeting, Washington, D. C. Secy., D. L. Cease, 1 Madison Ave., New York.

NATIONAL METAL TRADES ASSOCIATION

April 11, annual convention, Hotel Astor, New York. Secy., H. D. Sayre, New England Bldg., Cleveland, Ohio.

NEW ENGLAND RAILROAD CLUB

March 12, annual meeting, New American House, Hanover St., Boston, Mass. Secy., Geo. H. Frazier, 10 Oliver St.

NEW ENGLAND SECTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION

March 14-15, annual meeting, Hotel Kimball, Springfield, Mass.

NEW ENGLAND STREET RAILWAY CLUB

March 19, annual banquet, Hotel Somerset, Boston, Mass. Temp. Secy., H. A. Faulkner, 12 Pearl St.

RAILWAY SIGNAL ASSOCIATION

March 18, semi-annual meeting, New York. Secy., C. C. Rosenberg, Bethlehem, Pa.

SOUTHERN GAS ASSOCIATION

April 17-19, annual meeting, Jacksonville, Fla. Secy., E. D. Brewer, Atlanta Gas Light Co., Atlanta, Ga.

MEETINGS IN THE ENGINEERING SOCIETIES BUILDING

Date	Society	Secretary	Time
March			
5	Institute of Operating Engineers	H. E. Collins	8.00 p.m.
8	American Institute of Electrical Engineers	F. L. Hutchinson	8.15 p.m.
12	American Society of Mechanical Engineers	C. W. Rice	8.15 p.m.
14	Illuminating Engineering Society	P. S. Millar	8.15 p.m.
15	New York Railroad Club	H. D. Vought	8.15 p.m.
27	Municipal Engineers of New York	C. D. Pollock	8.15 p.m.
28	Institute of Operating Engineers	H. E. Collins	8.00 p.m.
April			
2	Institute of Operating Engineers	H. E. Collins	8.00 p.m.
5	American Institute of Electrical Engineers	F. L. Hutchinson	8.15 p.m.
9	American Society of Mechanical Engineers	C. W. Rice	8.15 p.m.
11	Illuminating Engineering Society	P. S. Millar	8.15 p.m.
16	New York Telephone Society	T. H. Lawrence	8.15 p.m.
19	New York Railroad Club	H. D. Vought	8.15 p.m.
24	Municipal Engineers of New York	C. D. Pollock	8.15 p.m.
25	Institute of Operating Engineers	H. E. Collins	8.00 p.m.

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Note—Numbers in parentheses indicate number of years the member has yet to serve.

MEETINGS OF THE SOCIETY

(*Continued*)

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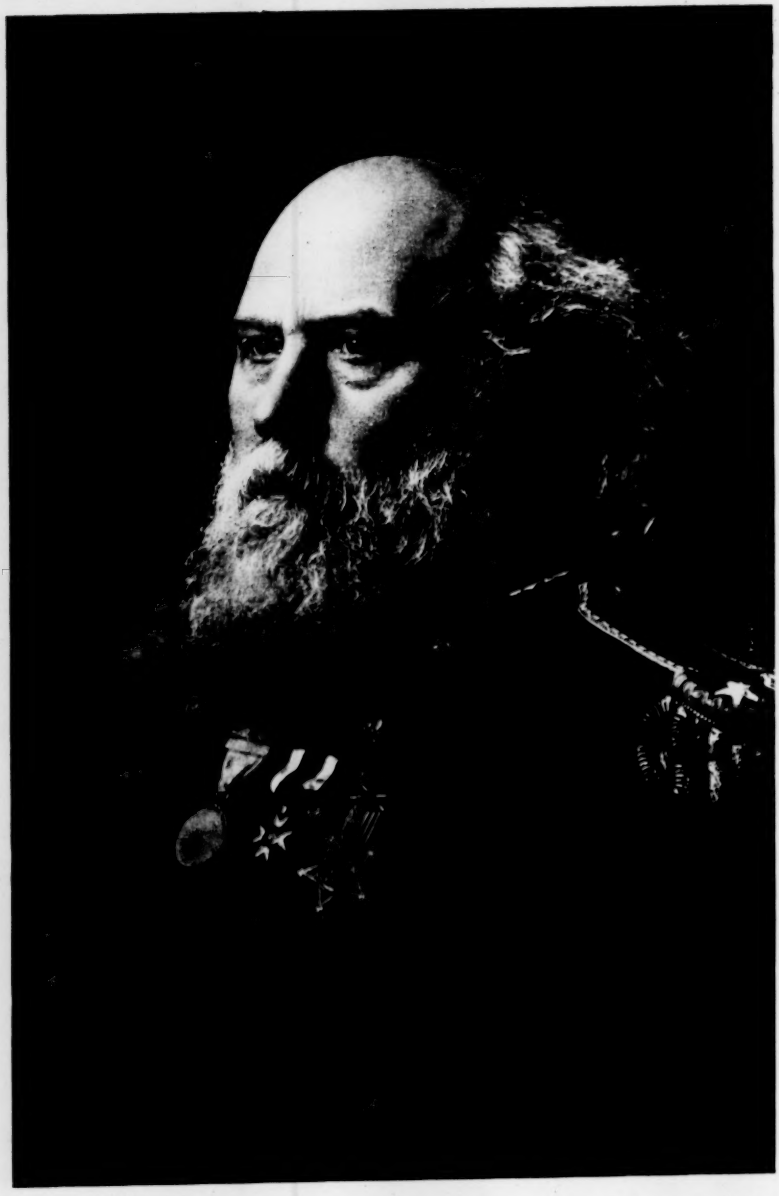

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